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Life cycle studies of some Antarctic mites and description of a new species, Protereunetes paulinae sp. n. (Acari: Eupodidae)

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LIFE CYCLE STUDIES OF SOME ANTARCTIC MITES AND DESCRIPTION OF A NEW SPECIES, PROTEREUNETES PAULINAE SP. N. (ACARI: EUPODIDAE).

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LIFE CYCLE STUDIES OF SOME ANTARCTIC MITES AND DESCRIPTION OF A NEW SPECIES, PROTEREUNETES PAULINAE SP. N. (ACARI: EUPODIDAE)

by

Elmer Elden Gless

A Dissertation Submitted to the
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Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

Chairman of Major Department

Signature was redacted for privacy.

Dean of Graduate College

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October 23, 1968

I hereby request that the changes listed below which I desire to make in the manuscript copy of the thesis submitted for the degree Doctor of Philosophy be approved.

Ellis A. Hicks

On page 58 it appears Stereotydeus belli Womersley and Strandtmann, 1963. It should read Stereotydeus belli (Trouessart) n. comb. Womersley and Strandtmann, 1963. Pacific Insects 5:458.

On page 72 it appears Stereotydeus belli Womersley and Strandtmann. This should read Stereotydeus belli (Trouessart) and on pages facing 74, 76, 78, 80, 82, 84, 86, 88, and 90.

Approved:

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INTRODUCTION

Hallett Station, Antarctica

At a meeting of the International Council of Scientific Unions held in Brussels, Belgium, during the summer months of 1953, a global program of geophysical observations was established. The framework of the program was such that national committees of interested countries were invited to investigate methods of support for the program. It was the general consensus of all committees that stations in Antarctica were desirable.

The National Academy of Sciences established a U.S. National Committee for the International Geophysical Year (IGY). A source of funds was needed so the Academy turned the entire operation over to the National Science Foundation as the appropriate federal agency to present the program to the Congress for funding. That committee then went to the second International Council of Scientific Unions held in Rome, Italy, in September, 1954, with plans for three antarctic scientific stations. The participating nations were the United Kingdom, Australia, New Zealand, Argentina, Chile, Norway, South Africa, Japan, France, U.S.S.R., and the United States (Dufek, 1959). After the meetings it was apparent that even with a total of 21 stations cooperating as proposed by the national committees representing all of the countries involved there were many gaps. Observatories were needed in additional areas on the continent. One area was along the Ross Sea between Cape Adare and Ross Island.

The first antarctic conference, held in Paris in July, 1955, considered the problem of distribution of stations. Before the second antarctic conference in September of that same year a working group for the coordination of stations and scientific programs was established. This group had solved many of the existing problems. The U.S. National Committee had determined to establish six stations. Logistical support for the entire antarctic operation was delegated by the Navy Department to Task Force 43, subsequently to be dubbed "Operation Deep Freeze".

It was suggested at the second antarctic conference that the United States and New Zealand occupy a station in cooperation along the Victoria Land Coast. Subsequently the United States National Committee decided that an additional station would be built in the vicinity of Cape Adare with programs in most of the physical sciences. Thus were planned "the seven cities" of Antarctica (Dater, 1965). Biology was not mentioned as a planned scientific discipline for the station.

The site was then to be chosen and the commander of the U.S. Support Force, Antarctica (CTF-43), directed Captain C. W. Thomas, USCG commander of Task Unit 43.1.2, to use the USCGC Edisto (AGB-2) in search of an appropriate location. The site was to accommodate an emergency air strip with radio homing potential, as well as being suitable for scientific research. (U.S. Naval Support Force, Antarctica, 1956).

The first place examined, and it appeared to be the most suit-

able, was Cape Adare with its Ridley Beach. Borchgrevink on the 1898 expedition of the Southern Cross for Australia, and Robert Falcon Scott's Northern Field Party in 1911 for England had overwintered there. The Edisto party attempted to put ashore in early February, 1956, but the gale winds and high surf prevented a landing until 9 February. Even then the motor whaleboat yawed dangerously and dumped the personnel on shore in a very cold and wet condition. Some of the men returned to the ship by helicopter while seven remained to carry out the survey. The Edisto's LCVP (small landing craft) managed to fire a shot line from some distance offshore and used it to haul the men aboard via a rubber life raft (Dater, 1965a).

The Edisto then left Cape Adare and proceeding south found a small spit of land at the south end of Moubray Bay. This spit was attached to Cape Hallett located at 72°18'50" south and 170°12'30" east. However, before investigating this small spot of land any further, the Edisto continued further south nearly to Coulman Island. Nothing suitable for a station was found and they returned to the tip of Cape Hallett. The spit of land was rectangular and inhabited by thousands of Adélie penguins (Reid, 1964). It was later named SeaBee Hook and the ship's commanding officer claimed the spit for a subdivision and distributed the lots among all present (Dater, 1965a).

After further consultation with representatives of IGY, SeaBee Hook was confirmed as the location desired for the seventh U.S. Ant-

arctic Station. It was protected by land; a water source from the high cliffs of Cape Hallett was available; and, if necessary, an air strip approximately 2,000 feet long could be constructed parallel to the cliff. Also, the site was suitable for meteorological observations. The navy construction crew arrived on 29 December 1956, and actual construction of the station was begun on 3 January 1957, (Dater, 1965b).

Of the stations established during IGY the Adare station was the smallest. The New Zealand Antarctic Society suggested that it not be called Adare Station but be named after Sir James C. Ross since it was actually not on Cape Adare. However, Hallett Station was soon accepted and the name continues today.[1] The Station continued for the IGY period and it was not until the end of that period and the beginning of the 1959 season that a biologist went to Hallett to investigate its flora and fauna.

Hallett Station was a success from the outset. It served its purpose well in many respects. The MCW(AM) radio homer is a valuable aid to the pilots flying the nearly direct route of Christchurch, New Zealand, and McMurdo Station on Ross Island. The emergency sea-ice air strip maintained there has been used on occasion when sudden deterioration of the weather at McMurdo does not permit the aircraft to continue.

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[1]Cape Hallett was named after Thomas R. Hallett, purser aboard the ship Erebus under the command of Sir James C. Ross on an earlier expedition.

Despite considerable cutbacks in antarctic research, Hallett has been maintained. Though it was reduced in 1965 from a winter-over station to summer only, it still is used for weather observation, emergency landing strip maintenance and biological research.

The Research Project

In 1965 the Entomology Department of the Bernice P. Bishop Museum, Honolulu, Hawaii, was awarded a grant from the National Science Foundation, Office of Antarctic Programs, to send one man to Hallett Station, Antarctica, for two summer seasons to study the biology of a mite. Upon application the writer was selected for the project.

After one week of orientation under the direction of the U.S. Antarctic Research Program (USARP, a section in the Division of Environmental Sciences) at Skyland, Virginia, in September, 1965, orders were issued to proceed to the Christchurch, New Zealand staging area in mid-October. Transportation was via U.S. Military Air Transportation Service (MATS) now known as Military Airlift Command (MAC).

In Christchurch an issue of cold-weather clothing was made and instructions in antarctic survival were given after which personnel were flown by a Navy Super Constellation to the main antarctic base at McMurdo Station on Ross Island at the edge of the Ross Ice Shelf.

At the Biology Laboratory at McMurdo, laboratory equipment needed and available was issued. Items required but not in stock

were ordered through North Star Research and Development Institute BioLab managers stationed at McMurdo. North Star had been contracted through the National Science Foundation to supply equipment to antarctic biology programs. Personnel and issued equipment were transported to Hallett Station, and shortly thereafter four other teams of scientists arrived.

The U.S. Navy logistical support team of SeaBees from Antarctic Support Activities (ASA, Task Force 43) had arrived earlier in October and had the station in full operation. All support activities were functioning well with the exception of water production which remained a problem the rest of the season as well as during the two following seasons.

The months of November, December and January were spent in surveying the area where mites were found as well as conducting some 24-hour microclimatological studies. Live mites were observed in their habitats and ecological data recorded. Live mites were also taken to the laboratory and placed in a refrigerated incubator for close and isolated observation. Also, some living mites were prepared for transport to Iowa State University for continued studies. That part of the program proved to be quite disappointing since the obstacles to transporting them were nearly insurmountable. A major problem was maintaining the specimens in cold temperatures and I had not been alerted to the U.S. Department of Agriculture requirement of spraying aircraft entering from a foreign land. No precautions were taken and fully 80 % of the cultures were killed.

For the second year a list of required materials and equipment was given to the Office of Antarctic Programs, which was forwarded to the North Star Research and Development Institute. The equipment was packed and shipped to Hallett Station in advance of my return in early October, 1966.

My appointment as Station Scientific Leader for the antarctic summer of 1966-1967 helped to alleviate some of the problems of space allocations and cooperation among the several programs at Hallett.

A second attempt was made to transport living material to Iowa State but it was a failure. Though precautions against insecticide contamination were taken, the trip was very long. I had remained at Hallett for the entire summer season, leaving in late February when the USCGC Glacier (WAGB 4) helped to close the station and evacuated all personnel. The ice breaker trip from Antarctica to New Zealand took seven days, and six more were required enroute to the United States. Under such conditions the cultures could not be attended properly, and mortality was so high that studies could not be continued for lack of specimens.

During the second season (1966-1967) success was attained in rearing one species of mite through one complete generation. In addition, two other species were reared from adult through the early stages of development to the last nymphal stage when the cultures were lost. A fourth species was reared from tritonymph to adult which established their relationship. Additional field

collected adults were then reared to deutonymphal stage before they also were lost.

My appointment by the Bishop Museum on their NSF grant was ended the second year. However, several members of the Office of Antarctic Programs suggested that since considerable work had been started but not completed, namely, the three species of mites that had not been successfully reared through to the second generation, a grant proposal for a third research season (1967-1968) should be made through Iowa State. This was done, resulting in a research grant being awarded by the National Science Foundation.

When planning field studies for the third season, it was decided that the return to Hallett would be delayed in comparison with former years because the peak of mite egg hatching is late December to late January. I arrived there on Christmas eve, 1967, to resume the life cycle studies. Specimens of the three species previously studied, but which were not reared through a complete generation, were collected and placed in refrigerated incubators. One additional species was reared through to the second generation; however, the other two became infected with a fungus and were lost.

In addition to microclimatological and ecological studies, life cycle studies of four species of mites are presented here. Two species have been successfully reared from tritonymph to adult of the first generation and to adult of the second generation. Additionally, a third species has been reared from tritonymph to adult then to tritonymph of the second generation while a fourth species has

been reared from tritonymph to adult then to deutonymph of the second generation. One, a new species, is named and described herein. A fifth species is reported as a new record for Hallett Station.

History and Present Status of Acarology at Hallett Station

The first entomological collections in Antarctica were made by members of the Belgica Expedition, 1897-1899. The Southern Cross Expedition, 1898-1900, was the first to overwinter on the continent proper and the second to make entomological collections. Its senior zoologist, Dr. Nicolai Hanson, who died at the end of that winter, had collected extensively at Cape Adare just 75 miles from Hallett Station. However, it was not until 1958 at the end of IGY that Madison E. Pryor was sent by the Polar Committee of the U.S. National Academy of Sciences to Hallett Station to investigate arthropod ecology (Gressitt, 1967).

Pryor subsequently spent two seasons at Hallett Station (1958-1959 and 1959-1960). His work was concerned basically with the environmental features in reference to soil arthropods. Pryor (1962) reported four species of Collembola, three previously described and one believed to be new. Also, he reported two prostigmatid species. One, Penthaleus belli Trouessart, 1903 [sic], reported to be of the family Eupodidae, has since been redescribed by Womersley and Strandtmann (1963) as Stereotydeus belli (Trouessart, 1902) and is correctly placed in the family Penthalodidae. The second, Stereotydeus (Tecto-

penthalodes) villosus (Trouessart), 1903, has since been redescribed by Womersley and Strandtmann (1963). It was correctly placed in the family Penthalodidae by Pryor but it has never been reported by other workers, and he possibly made a misidentification since Stereotydeus villosus has only been reported from the South Shetland Islands and in the region of the Antarctic Peninsula approximately 2,700 miles away.

Halozetes antarctica (Michael, 1903) and Pertorgunia belgicae (Michael, 1903) were two oribatid mites also reported by Pryor (1962). They have never been reported from Hallett Station since that time. Halozetes antarctica is now known as Alaskozetes antarctica (Michael, 1903) by Wallwork's redescription (1962).

A thorough examination of the Hallett Station study area by the writer has never revealed specimens of the two oribatid mites mentioned above. One mite, Maudhemia petronia Wallwork, 1962, is prevalent in the study area and has been found in all ecological habitats described for the two species named by Pryor except on the surface of melt pools. Therefore, as suggested by Gressitt (1968) it is assumed that the mites collected by Pryor are just different stages of M. petronia.

After Pryor's two seasons at Hallett Station, several researchers made entomological collections. During the summer of 1960-1961, C. Bailey, E. B. Fitzgerald and Brian Reid, who constituted a New Zealand ornithological team, submitted specimens to the Bishop Museum.

J.C.L.M. Mather, employed by the Bishop Museum to operate insect nets aboard a ship in the antarctic waters during the 1962-1963 summer, collected briefly at Hallett. And, in 1964, J. L. Gressitt, K.A.J. Wise and John Shoup, a Bishop Museum entomology team, ran several transects, made several 24-hour microclimatological observations, and collected mites and collembola extensively (Gressitt, 1967). All prostigmatid mites collected since Pryor's time were eventually given to R. W. Strandtmann of the Bishop Museum, who has described most of the specimens collected from Hallett Station.

Until this writing the mites described from Hallett Station and vicinity were as follows:

PROSTIGMATA:

Penthalodidae

Stereotydeus belli Womersley and Strandtmann, 1963
S. punctatus Strandtmann, 1967
S. delicatus Strandtmann, 1967

Eupodidae

Eupodes wisei Womersley and Strandtmann, 1963

Rhagidiidae

Coccorhagidia gressitti Womersley and Strandtmann, 1963

Tydeidae

Tydeus wadei Strandtmann, 1967
Tydeus setsukoae Strandtmann, 1967

Pachygnathidae

Nanorchestes antarcticus Strandtmann, 1963

CRYPTOSTIGMATA (ORIBATEI):

Oribatulidae

Maudhemia petronia Wallwork, 1962

DESCRIPTION OF THE STUDY AREA

Origin

Hallett Station at coordinates 72°18'50" south and 170°12'30" east is situated on SeaBee Hook at the north end of Cape Hallett, a rugged volcanic peninsula located in the Admiralty Range of mountains in North Victoria Land. It is on the west side of the Ross Sea and is approximately 75 miles south of Cape Adare (Fig. 1).

The predominant westerly winds between latitudes 62° and 70° south in conjunction with the predominant southeasterlies of the more southern latitudes create a clockwise sea-water movement. Thus, the current past Cape Hallett and associated Moubray Bay passes into the northern reaches of the Ross Sea, (U.S. Navy, Secretary, 1960). As the current moves past Cape Hallett it brings large amounts of floating ice from the southern parts of the Ross Sea. The ice pieces vary in size and measure from the most minute to huge tabular bergs sometimes a mile or more in diameter and hundreds of feet high. The pieces arise from annual ice frozen during the preceding winter and from the continually active glaciers feeding into the sea from the interior of the continent. The "icebergs" are nearly always flat or tabular, a characteristic resulting from the expanding and settling of the Ross Ice Shelf. These contrast greatly with the large, irregularly shaped icebergs seen in the Arctic.

The tabular form of annual ice, commonly referred to as pack-ice, is conducive to a shovelling effect along the coastal regions as the tides and currents push and shove the ice to the shore. The shovelling effect picks up pieces of terrestrial material, moving it from one area to another. Annual ice that is frozen in along the flat beaches during the following winter will pick up gravel and rocks by an adfreezing process, which slightly enlarges the icebergs. When the spring breakup occurs, the adhering material is carried away. The large tabular icebergs of glacial origin also carry large amounts of terrestrial material that has been adfrozen from the surface of the continent during the glacier's journey to the sea. Rocks and gravel often can be seen adhering to surfaces of overturned ice chunks and can sometimes be seen embedded deep within the ice. Between the annual ice and the glacier ice a rather large amount of such material is picked up. The ice pieces drift past the cape, eddy into Moubray Bay and Edisto Inlet, and in so doing slowly melt or otherwise discharge their cargoes (Fig. 2). In many instances the rocks and soil particles are carried great distances from their geological origins. The described process continues today. A predominant location for deposit of the collections has been on the west side of the cape and about 700 meters south of the point. The cape acts as a jetty or breaker to the great physical momentum of the turbulent sea. The underlying structure is probably a deep underwater moraine from the peninsula that arose either by talus fall

from the cape or by glaciation from the southern part of the inlet.

Tidal and wave action around the hook is such that the foreign materials brought into the area by the icebergs are driven up onto the land. The more forceful action along the leading edge (northern) of the spit has resulted in the high ridge along that area. The drifting ice in the less turbulent area south of the hook has resulted in the low sandbar extension of the hook. The motion of the ice with the current can be easily observed from atop the cape on a clear day during the midsummer season. In this manner SeaBee Hook has been built.

Topography

The size of SeaBee Hook has been estimated by Reid (1964) at 101.05 acres: 22.5 for the triangular beach area and 70.0 for the spit extension. The elevation averages five meters above sea level. Small hummocks formed by annual nesting of the Adélie penguin average from a few centimeters to about one meter in height and are scattered over the main portion of the hook, the principal nesting area. The older beach area is separated from the hook by Willett Cove approximately 150 meters wide. East of the cove is the main skua nesting area (Fig. 3).

The varieties of rocks found along the flat beach east of Willett Cove attest to the many iceberg visitors as well as the extinct volcanic cones of 5,700 foot Mt. Geoffrey Markham. It is the highest point of the Cape Hallett peninsula. Underlying the loose, weather-

worn rocks is a porous, sandy soil filling in between the larger and more permanent rock substrata. The whole area, triangular and flat, extends about 100 meters east of Willett Cove at the north end. A road used by the U.S. Navy Support Force SeaBees to haul water from the glacier to the station runs along the beach edge and is traversed by shallow drainage marks that carry water from the melting snow and ice of the steep cliffs of the cape (Fig. 3). The beach edge and the moraine below the ice fall form the apex of the triangle at the southern end.

Soil

The soil, a term used in the most basic form (i.e., it is that portion of the earth's crust which under optimum conditions can support plant life), is mostly acidic. Calcium carbonate, leached from quartzose-, meta-greywache, argillite, and meta-argillite as well as from some metamorphosed limestone can be found in deposits at two levels (Harrington, 1958). Traces of white to crusts of white carbonate deposits measuring 0.5 cm in thickness can be found on the surface as well as at the permafrost level at depths of about 20 to 30 cm. Soils near and in the penguin rookery are difficult to define. Such areas are usually alkaline from the layer of guano continually deposited there during the breeding seasons. These areas always lack soil-dwelling arthropods. A probable cause could be that the high alkalinity inhibits vegetative growth, the food source. Such areas are not considered in this study.

Alluvial fans are formed during periods of thawing and are quite unstable. During dry periods and high winds the finer portion blows away. Solifluction is not in evidence. However, frequent and near-cyclic freezing and thawing combined with air movement are the major factors involved in soil development. In Pryor's words:

> "The prevailing wind at Hallett Station approaches from glacier and snow-covered areas and continues across the station towards the sea. . . . on the talus slopes, an obvious difference was noticed in the texture of soils from windward to leeward areas. . . . minor topographical variations produced major differences in soil texture and rate of accumulation."

Soils near and in the skua nesting sites have always been found to be fertile micro-arthropod areas. Pools that receive melt-water from the upper reaches of the talus slopes and have a water-holding capacity were found to be slightly acid and nearly always supported moss and algae. In such areas the soil in association with the moss-algae beds is unique with a layer of spongy sediment and organic debris beneath the living vegetation and extending down to permafrost. The organic debris consists of bird feathers, egg shells, bones, dead moss gametophytes and rhizoids. It reveals a brownish muddy appearance not too unlike that found on a marsh edge of the midwestern United States. In the midst of the vegetation and soil building area the pH was found to be 6.9 to 6.6 while on the periphery the pH tended to be more acidic, 3.9 to 6.7. The rivulets of melt-water from the snow and ice fields atop the cape indicated a pH constant of 4.8. Only in temporary melt pools without vegetation growths was the

pH found to be excessively basic 7.8.

Soil samples from seven sites are listed as follows (see Fig. 3):

1. Due north of site B (ca. 50 feet).
2. At generator site for research site A.
3. Due north of research site C (ca. 50 feet).
4. At site B.
5. Above and left of rock in center of Fig. 48.
6. Beneath rock in center of Fig. 48.
7. One foot from edge of penguin colony at northern end of skua rookery. Near mouth of drainage at bend in SeaBee road.

Analyses of the samples will be found in Table 1. Particle size analyses were conducted by use of U.S. Standard sieves. Organic matter and hydrogen meq/100g exchangeable cations were determined by wet combustion as outlined in Russell (1967). Total nitrogen was conducted by the Kjeldahl technique described in Bremner (1965, pp. 1164-1166). All calcium and magnesium analyses were by atomic absorption and all potassium and sodium analyses were by flame photometer.

Flora

The vegetation of the study area is sparse by nearctic or even arctic standards. However, the abundance of lichens and mosses at Hallett Station is well above the norm for the major portion of the continent. Visitors to the area are often astounded by the compara-

Table 1. Analyses[a] of soils from seven sites in study area by sample number

Feature	1	2	3	4	5	6	7
Particle size							
2 - 1 mm	18.1	36.6	43.9	39.4	27.1	26.8	30.3
1 - 0.5 mm	41.0	33.0	35.6	30.2	19.0	25.7	36.9
0.5 - 0.25 mm	29.4	15.0	12.7	10.8	18.2	19.1	23.9
0.25 - 0.125 mm	8.3	8.0	4.6	9.2	26.2	18.3	5.8
0.125 - 0.100 mm	0.6	1.4	0.4	4.0	0.7	1.7	0.7
$<$0.199 mm	2.6	6.0	2.8	6.4	8.8	8.4	2.4
pH	4.0	4.5	4.7	6.7	5.8	3.9	7.7
Organic matter	1.7	1.4	0.9	0.8	16.3	9.1	1.3
Nitrogen	0.11	0.14	0.5	0.09	0.64	0.51	0.17
Exchangeable cations meq/100g							
Hydrogen	8.97	4.69	2.69	2.52	16.55	16.82	0
Calcium	0.18	0.09	0.31	2.33	3.18	1.32	0.52
Magnesium	0.09	0.35	0.23	1.12	1.74	0.52	2.08
Potassium	0.05	0.12	0.07	0.34	0.23	0.14	0.07
Sodium	0.24	1.03	0.79	2.77	2.47	1.09	0.49
Water extractable cations meq/100g							
Calcium	0.004	-	T[b]	T	T	0.130	0.003
Magnesium	0.036	-	0.034	0.003	0.002	0.172	0.596
Potassium	0.03	0.27	0.03	0.01	0.08	0.12	0.15
Sodium	0.23	1.77	0.34	0.15	0.77	0.73	0.43

[a]Analyses conducted at Iowa State University Agronomy Department.

[b]T = trace, $<$0.003.

tive floral richness. Because of the vegetative abundance found in all of North Victoria Land the exaggerated term "Banana Belt" is often heard, especially from the military support force personnel of Operation Deep Freeze.

Lichens predominate with at least 13 species found within one mile of the study area. One moss species is common to the slopes as are three algae species (Lange, 1966; Rudolph, 1965).

Fungal mycelia are frequently observed in soil samples, however, none has been reported in the literature. It has been suggested that these are symbiotic associates of an alga that makes up a lichen growth (Gannutz, 1966). Contamination of charcoal rearing media was a major problem that had to be overcome before successful rearing of mite cultures could be accomplished. Attempts at identification were not made since time and facilities were lacking.

In the drainage area at the northern end of the study area between the penguin and skua rookeries a chlamydomonas grows in abundance. The slow-moving portions of the drainage at the peak of the summer season show bright green color from the concentrated numbers.

Bacteria have been found in nearly every portion of the study area. They are especially abundant in and near the bird nests.

A complete survey of the local flora is not within the scope of this research project. Determination of species has been mainly dependent upon personal communications with other researchers. The more abundant floral species are listed on the following page.

Algae:

Prasiola crispa (Lightf.) Menegh.
Ulothrix sp.
Nostoc commune Vauch.
Oscillatoria sp.
Navicula sp.
Navicula multicopsis van Heurek

Mosses:

Bryum argentium Hedwig

Lichens:

Xanthoria mawsoni Dodge
Candelaria concolor (L) Wain. var. antarctica Murray (Rudolph, 1968)
Candelaria sp.
Caloplaca elegans (Link) Th. Fr. var. pulvinata (Dodge and Baker) Murray (Rudolph, 1968)
Caloplaca sp.
Buellia frigida (Darb.) Dodge
Buellia sp.
Rinodina sp.
Parmelia coreyi Dodge and Baker
Lecidea sp.
Physcia sp.
Lecanora sp.
Umbilicaria sp.

Fauna Other Than Soil Mites

Unidentified, freeliving soil nematodes were often found in the soil flotations examined for mites. Rotifers were also present in abundance and tardigrades to a lesser extent. Protozoans of the class Ciliata were prevalent and always found in conjunction with the blue-green alga, Prasiola crispa.

Of the larger animals observed in the study area birds are the most abundant. They are:

Pygoscelis adélie Hombron and Jacquinot (Adélie penguin)

Catharacta skua maccormicki Saunders (Southpolar skua)

Macronectes giganteus (Gmelin) (Giant petrel)

Pagodroma nivea (Forster) (Snow petrel)

Oceanites oceanicus oceanicus (Kuhl) (Wilson's storm petrel).

Limited numbers of the last two species inhabit the rocky cliffs of the cape above the study area. Skeletal remains of young petrels have been found in feather boluses in the skua nesting area. Though the skua is basically a scavenger and secondarily a predator at this particular site, it is possible that petrel chicks as well as eggs are occasionally part of their diet. The nearest known giant petrel nesting site is on Possession Island 30 miles north. The emperor penguin (Aptenodytes fosteri G.R. Gray) is frequently seen on the offshore ice. It rarely and unwillingly comes on land. I saw it on the soil surface of the study area only once during three seasons.

Four species of seals indigenous to Antarctica are occasionally seen in the study area. Usually it is late in the season when there are few or no ice cakes nearby upon which they can seek refuge that they venture out on the soil surface. The four species are:

Leptonychotes weddelli (Lesson) (Weddell seal)

Lobodon carcinophagus (Jacquinot and Pucheran) (Crab-eater seal)

Hydrurga leptonyx de Blainville (Leopard seal)

Ommatophoca rossi Gray (Ross Sea seal)

Two subantarctic animals have been observed on the shores of the study area by the author. They are the elephant seal and the

chinstrap penguin, Mirounga leonina (Linné) and Pygoscelis antarctica (Forster) respectively.

Mallophaga of both suborders, Ishnocera and Amblycera, have been reported from the skua (Clay and Moreby, 1967). Several species of mites have been collected from the skua also (Atyeo and Peterson, 1967).

The only indigenous insects found in the study area belong to the order Collembola. Pryor (1962) reported Isotoma klovstadi Carpenter, 1902, Cryptopygus antarcticus Willem, 1902, Gomphiocephalus hodgsoni Carpenter, 1908, and a new species believed to belong to the subantarctic genus Colonavis Solomon, 1949.

Isotoma klovstadi is found in the study area as is the genus Cryptopygus. Wise (1967) has described a new species C. cisantarcticus.

Gomphiocephalus hodgsoni is not found in the study area. Pryor's (1962) report was in error according to Wise (1967).

The species believed to be new and to belong to the genus Colonavis has not been reported in the literature.

The taxonomic status of the insect fauna in the study area has been brought up to date by Wise (1967). From his paper it has been determined that three species of springtails occur in the area, two of which have been mentioned and the third is Friesea grisea (Schaffer, 1897).

Study mounts of collembola were prepared occasionally as mites were cleared and mounted on slides. Collections preserved in alcohol are to be sent to the Bishop Museum.

Collembola were very numerous in the study area. Rarely were soil samples taken that did not contain them. They were found at sites _ . where mites have not been found and seem to be able to live in soil completely devoid of vegetation. At the same time they could be observed on warm days crawling about on rock surfaces and clumps of Bryum argentium. When melt water from the upper reaches of the cliff ran through areas of vegetation or pools nearby, thick black clumps of these insects could be observed on the water surface. When water samples with specimens floating on top were placed in the refrigerated incubator at 5° C, the contact with the water seemed to stimulate egg hatching and ecdysis. A short experiment in the laboratory demonstrated that molting could be controlled to some extent in that manner. This is mentioned here as a possible aid for future study.

As more information is brought to light concerning soils, vegetation and microclimate, it is suggested that a study of the population dynamics of these insects would be in order. Their availability and the marked variation in numbers relative to vegetation areas render them quite appropriate.

Fig. 1. Hallett Station area from Tucker Glacier District Geological Map of Ross Dependency, Department of Scientific and Industrial Research, New Zealand, 1963. Scale of one inch equal to 6.5 km.

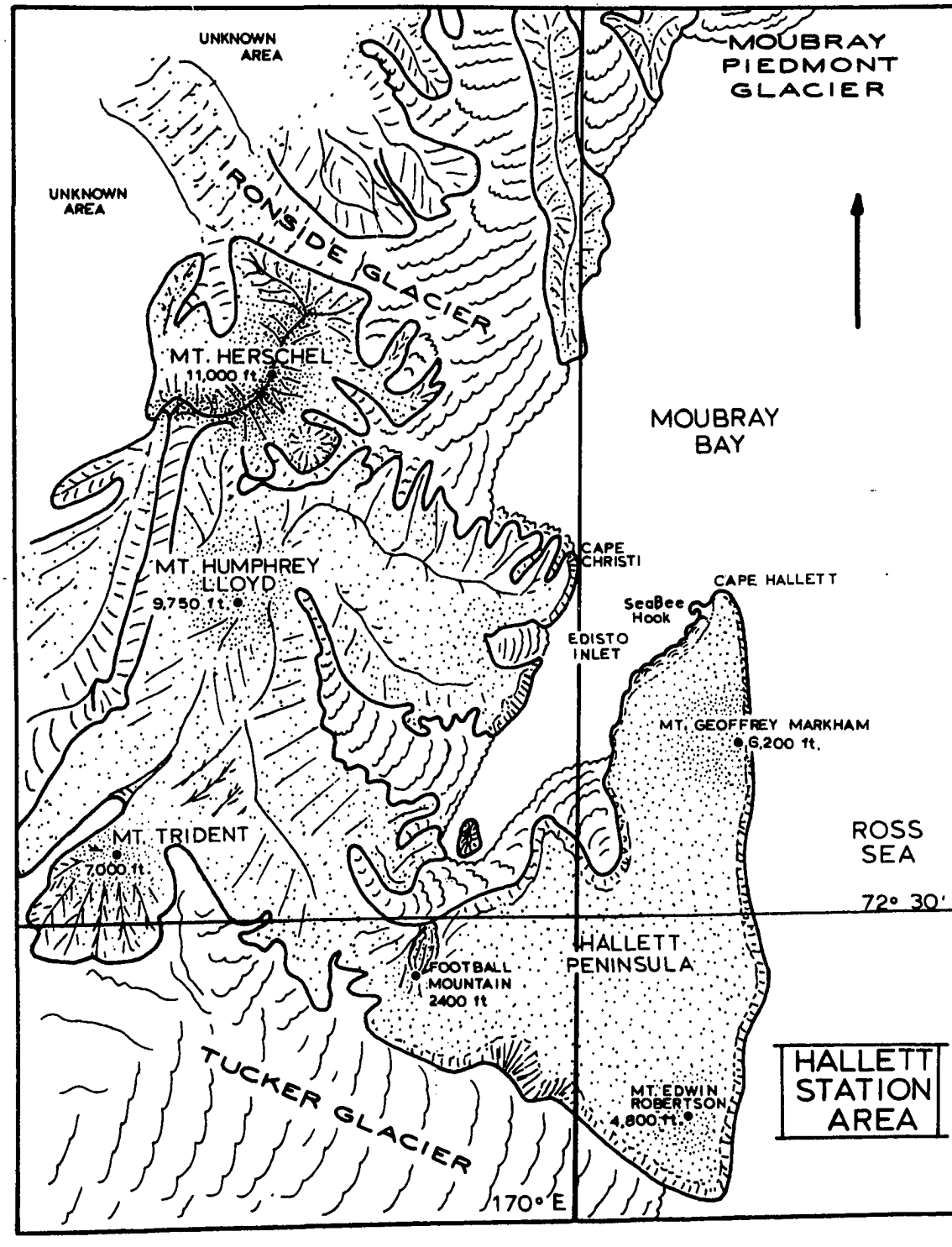

UNKNOWN AREA
MOUBRAY PIEDMONT GLACIER
UNKNOWN AREA
IRONSIDE GLACIER
MT. HERSCHEL 11,000 ft.
MOUBRAY BAY
CAPE CHRISTI
CAPE HALLETT
SeaBee Hook
EDISTO INLET
MT. HUMPHREY LLOYD 9,750 ft.
MT. GEOFFREY MARKHAM 6,200 ft.
MT. TRIDENT 7,000 ft.
ROSS SEA
72° 30'
HALLETT PENINSULA
FOOTBALL MOUNTAIN 2400 ft
TUCKER GLACIER
MT. EDWIN ROBERTSON 4,800 ft.
170° E
HALLETT STATION AREA

Fig. 2. Aerial photo of Hallett Peninsula and SeaBee Hook from U.S. Navy Helicopter, 3 February 1967. USCGC Glacier (WAGB-4) Coast Guard Icebreaker is at left.

Fig. 3. SeaBee Hook and Hallett Station, Antarctica.

Legend

Ⓐ , research site A

Ⓐ , generator site for A

Ⓑ , research site B

Ⓒ , research site C

SK, skua rookery

, fresh water pool

, beach line

PEN, main penguin rookery

STA, Hallett Station proper

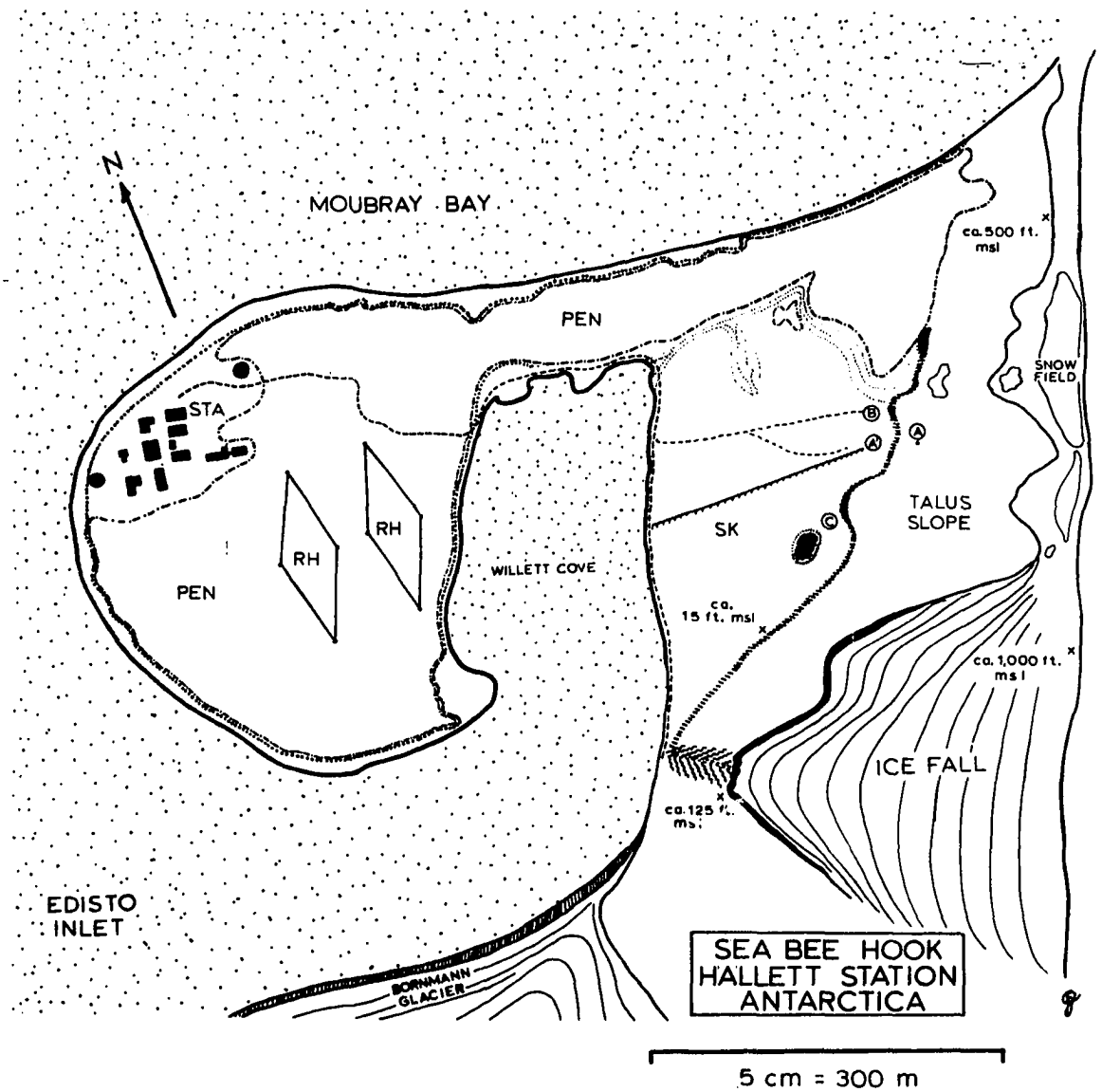
--------, road

RH , rhombic antennae

, transect line

, fresh water drainage

, edge of talus slope


N
MOUBRAY BAY
ca. 500 ft. msl
PEN
SNOW FIELD
STA
B
A
TALUS SLOPE
RH
RH
SK
C
WILLETT COVE
PEN
ca. 15 ft. msl
ca. 1,000 ft. msl
ICE FALL
ca. 125 ft. msl
EDISTO INLET
BORNMANN GLACIER
SEA BEE HOOK
HALLETT STATION
ANTARCTICA
5 cm = 300 m

BIOLOGICAL INVESTIGATIONS

Field Investigations

Collection methods

Several techniques were employed for collection of soil arthropods in the earlier stages of the investigations. Primarily, observations were conducted in the field by examination of loose rocks with a biologist's hand lens. In a few instances when mites were observed in large groups on the under surface of rocks, a camel's-hair brush was used to collect them in containers of alcohol. At times the brush was moistened with alcohol and touched to the mites which would then adhere to the brush. They could then be washed free from the brush into the container. This technique did not work well when lichens and mosses were examined in the field. The majority of the mites inhabiting lichens were of the genus Tydeus and were much smaller than those of the genus Stereotydeus found in groups on the under surfaces of rocks. They were difficult both to see and to collect because the lichens would break easily from brittleness in the prevailing low humidity. When wet the lichen pieces and the mites were very difficult to separate by use of a low-powered hand lens.

In a few instances rocks and lichens with mites were hand carried to the laboratory to be examined. In most cases the bare rocks would be found to be nearly devoid of mites upon return. When the lichens and mosses were examined, individual mites would be removed

laboriously to alcohol containers by use of Irwin Loops® [1] dipped in alcohol. Mites were never collected from large mats of algae (Prasiola crispa).

In the early stages of the investigations soil samples were taken at varying places in the field, placed in plastic bags, tied and marked. These samples were then transported to the laboratory where Tullgren funnels had been previously set up. The technique was varied by using a wattage range (20 to 150) of light bulbs above the samples and use of naphthalene flakes over cloth. Though success in use of Tullgren funnels has been reported by others in Antarctica, in all my trials the attempts to force mites or collembola down and into alcohol were unsuccessful. Not one specimen was collected by this technique. The reason is believed to be the very low humidity in the laboratory and the rapid drying of the samples. The specimens could not survive such humidity conditions in addition to the increased temperature. Flotation of the samples would often reveal freshly dead and very old broken remains of mites and collembola.

One trial using naphthalene flakes was conducted by moving the funnels to the colder climate outside the laboratory building. Wet towels were wrapped around the apparatus in an attempt to maintain a higher humidity. That trial was also a failure. It is suspected that the naphthalene fumes were toxic to the mites. No attempt was

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[1] Irwin Loops®, Welch Mfg. Co., stainless steel and rust resistant in chloral hydrate clearing solutions. Name used throughout text.

made to force the mites to migrate in the opposite direction, i.e., from the bottom of the sample to the top. If there was any movement of the creatures in that direction, it was not noted. Time and facilities for development of a suitable recovery technique incorporating Tullgren funnels were limited, subsequently the method was abandoned.

As soil samples were brought to the laboratory for funnel separation, some were utilized for flotation. The first attempt used available tap water. It must be understood, however, that tap water at Hallett Station was somewhat different than that found in the average United States location. In the early parts of the season distilled seawater, which was the main source of supply at that time, was pumped to individual supply tanks located in each building of the encampment. As the summer season progressed, water was collected from the freshets cascading down the talus below the Ice Fall (Fig. 3).

The pH values for both the distilled seawater and the fresh glacial melt water were always found to be approximately 4.8. Spot tests revealed little or no mineral content.

Recovery of mites from samples by use of tap water was always good. However, in attempts to improve recovery the specific gravity was changed chemically by use of sodium hexametaphosphate ($NaPO_3$, a water conditioning agent), magnesium sulfate ($MgSO_4 \cdot 7H_2O$), sodium chloride and sucrose - all in varying amounts.

Water was also used in combination with diesel fuel to form an interface between the two liquids, a technique patterned after Salt and Hollick, 1944. It was hoped that mites could be trapped in the

interface thus allowing the lighter organic debris to be removed from the surface. This technique worked quite well for the genus Tydeus but was unsuccessful for all others.

In all instances of chemically changing the specific gravity, the success was only as good as or less than that from use of available tap water. The percentage of chemicals employed for specific gravity change can be seen in Table 2. The dishes employed for flotation were straight-sided, biological specimen bowls 115 mm diameter and 55 mm deep with a volume of 350 ml.

Table 2. Chemicals employed for changing specific gravity of solutions used for soil sample flotations

Chemical and grams		Milliliters water
$NaPO_3$	75	75
$MgSO_4 \cdot 7H_2O$	50	100
NaCl	saturated	
Sucrose	25	100

Aspirators were frequently used for collection of mites from the overturned rocks. Some damage was noted, especially with the species E. wisei with their long and fragile legs I. When the occasion warranted, a small amount of alcohol was placed in the receiving container of the aspirator. This reduced damage to mites but the evaporation of the liquid and subsequent condensation in the intake end of the collecting tube created a wetness to which the mites would adhere. The only way they could then be removed was to wash them with a stream of alcohol, which was bothersome and diffi-

cult if not impossible to undertake under field conditions.

In some instances a polyethylene wash bottle of 80 % ethyl alcohol, with a fingerbowl for a receiver, was taken to the field. When a stone with desired mites on it was located, it was washed over the bowl. The wash was then poured into a sealed container for return to the laboratory. This technique, though limited in several ways such as size of rock that could be easily or efficiently handled and quantity of alcohol needed, was quite satisfactory. However, recovery of the mites was not as easy as flotation since they were always on the bottom of the container and had to be sorted from the debris that was also washed off the rock. Use of forceps was impracticable because of the mites' small size and fragility.

A modification of a pit-fall trap was used on several occasions. Open petri dishes with solutions of non-freezable alcohol were placed in strategic positions on rock surfaces for varying periods of time. It was expected that any jumping or otherwise wandering arthropod would be caught in the solution. The alcohol would invariably evaporate within an hour or so thus rendering the trap useless. However, some success was attained by using a solution of formaldehyde (2.0 %), alcohol (40 %), and water, placed out on warm sunny days. Rock surface temperatures on these days sometimes reached a high of 90° F. The only specimens trapped were Stereotydeus belli and the ever present collembola.

The collection technique utilized most and resulting in greatest return for effort involved was flotation of soil samples with

distilled seawater or glacier melt water. Specimens collected on the surface of the flotation were often used for cultures of living specimens. Often the mites were injured; however, with practice a mite that was not injured and suitable for culturing could be recognized. With the use of Irwin Loops usable mites could be removed to the culture dish and incubator.

Macro-weather data

Hallett Station is about 1,200 miles from the geographical south pole and, in contrast to most antarctic stations, is not situated on a snowfield. SeaBee Hook is located at the north and seaward end of the "V" shaped valley that forms Edisto Inlet. Along the western boundary of the inlet are the rocky cliffs that form the bases for Mts. Trident, Humphrey Lloyd and Herschel. To the east is Cape Hallett rising abruptly from sea level to about 1,000 feet. From there it gently slopes upward to Mt. Geoffrey Markham at 6,200 feet.

The station is oriented NE-SW. The southern end or bottom of the "V" is about five miles wide from glacier wall to glacier wall while the northern or top end is about 15 miles wide (Fig. 1). The prevailing wind from the south-southwest seems to pick up momentum as it passes the station. Ice movement and tide in Moubray Bay seem to be closely associated with surface winds.

Immediately south of SeaBee Hook is Bornman Glacier which juts out approximately one-half mile into Edisto Inlet. Generally the southerly wind must flow across the glacier before reaching the station thus affecting temperature and humidity.

Continuing north of the station there are no obstructions to the wind until it reaches the Mcubray Piedmont Glacier about 20 miles north. At that point the air mass flows directly into and over the end of the Admiralty Range of mountains then continues on to Cape Adare.

Benes (1959) reported the lowest temperature at -44° F in July and the highest of +42° F in January, 1957. He also reported sustained winds of 80 knots per hour (the word knots will be used hereafter to signify knots per hour), with gusts to 99 knots during October, 1957.

The prevailing wind at Hallett Station is S-SW, and a daily mean velocity of 26.5 mph was recorded for 1959 (Pryor, 1962). Gusts of wind have been recorded at speeds of 100 mph while occasional winds from the north are much less strong. It should be pointed out that although there are tremendous extremes, the area is not constantly swept by high winds. Many days the wind velocity is so low that it cannot be measured.

Since Hallett Station was closed as an over-wintering facility in March, 1965, there are no weather records for March through September during the ensuing years. The daily maximum and minimum temperatures recorded at the station for the austral summers 1965-1966, 1966-1967, 1967-1968 can be seen in Fig. 4.

The percent relative humidity in relation to wind speed and direction at three-hour observations during selected days of the 1965-1966 and 1966-1967 seasons will be seen in Figs. 5 and 6. The macro-weather data for the 1967-1968 season are not available at

this writing. The horizon angle at 10-degree azimuth increments for research site A (Fig. 3) can be seen in Fig. 7. The research site is approximately 0.6 km due east of the station. The cliff shadows of Cape Hallett are somewhat influential in the overall weather picture at the immediate station vicinity as well as at the research sites located at the very edge of the cliffs. Figs. 5 and 6 show that the humidity generally is reduced during the hours 0900 to 1800. In some instances it is not the case as on 20 February 1966 (Fig. 5). It must be pointed out that the cloud and haze cover on that particular day was estimated total for those hours and somewhat less for the remaining parts of the day. A more detailed correlation of sunlight and wind velocity, and direction to humidity and location of snowfields in relation to the research sites will be found in the section on HABITATS.

At Hallett Station the form of precipitation is always snow or hoarfrost. For the summer months of November, December, January and February precipitation is negligible. Pryor (1962) reported a total 1959 accumulation of 24.3 cm of water recorded, and of that total 20.5 cm fell during March, May, July, August and September. Because of the high surface winds that usually accompany snowfall, it is virtually impossible to accurately measure precipitation at any time.

Transect data

In an effort to ascertain more exact information concerning mite populations a transect of the skua rookery was sampled and evaluated. Beginning 9 January 1967, a line was sited by alignment of

the two, southernmost, tall, wooden antennae poles (the south ends of the two large rhombic antennae) and research site A on the talus slope (Fig. 3). A string was laid out along that line beginning at the edge of the road leading to the ice fall at the south end of the skua rookery. When the string was satisfactorily straightened and weighted with stones, population samples were taken. Beginning with a point approximately three meters east of the road a total of 135 stations were evaluated at one-meter intervals along the string. Sampling was conducted by placing a wire square of number 9 guage measuring one foot square on the ground at each measured meter of distance. Whether the square was placed on one side or the other or strictly parallel to the string was dependent upon a choice of rock surface. At no time did the distance from the string exceed one foot.

Within the marked off area all rocks, stones or other materials (bones, egg shells, etc.) that measured one-and-one-half-inches or more in diameter were picked up and examined for arthropods. All specimens observed with the naked eye were picked up with an aspirator, preserved in alcohol and labelled. A sample of the underlying soil was placed in a plastic bag. The sample was then taken to the laboratory for flotation. The soil samples averaged 350 to 400 grams. No records were kept as to exact amounts of soil nor was a description made of soil type.

The aspirator and flotation specimens were examined microscopically by use of a dissection microscope and results were recorded. Only adult mite specimens were noted; however, immatures were saved

for future examination. The vegetation types in association with the sample sites were recorded also. Wind speed and direction were noted.

The adult mites collected were listed only to genus. All developmental stages of collembola were recorded and no effort was made to differentiate between instars.

Laboratory Investigations

Specimen preparation

Specimens collected and preserved for study purposes were placed in 30 mm stender dishes containing 80 % ethanol until they could be prepared for microscopic observation. Mites selected for close observation were later transferred to Nesbitt's solution with a fine-tipped dropping pipet or Irwin Loop. After several trials the clearing agent was replaced with one prepared without 2.5 % HCl, i.e., 40 g of chloral hydrate to 25 ml of water. It seemed that the more delicate and fragile immature stages were too severely damaged by the acid. Experience of trial and error dictated how long the specimens were to be left in the clearing solution. Indicated optimum times for several species and their developmental stages will be found in Table 3.

If left in the solution much longer than the indicated times the specimens collapsed or "crenated" in the mountant. If left for too short a period, the protoplasm only partly cleared, the remains of which congealed to colored droplets within the exoskeletal structure. Such droplets almost always resembled an oil and changed the

light diffraction in various portions of the body and legs. In either event the resulting preparation was nearly useless. At all times the clearing process was conducted at room temperature of 65° to 70° F. If the temperature was increased by placing the container near a heat source such as a light bulb used in the slide drying chamber, the clearing was shortened considerably. The optimum state of clearing was critical, therefore use of heat which made timing more important was avoided except in the case of the more heavily sclerotized adult forms of S. belli and C. gressitti.

Table 3. Time in modified Nesbitt's solution[a] for several species and developmental stages of mites for optimum clearing preparatory of slide mounting

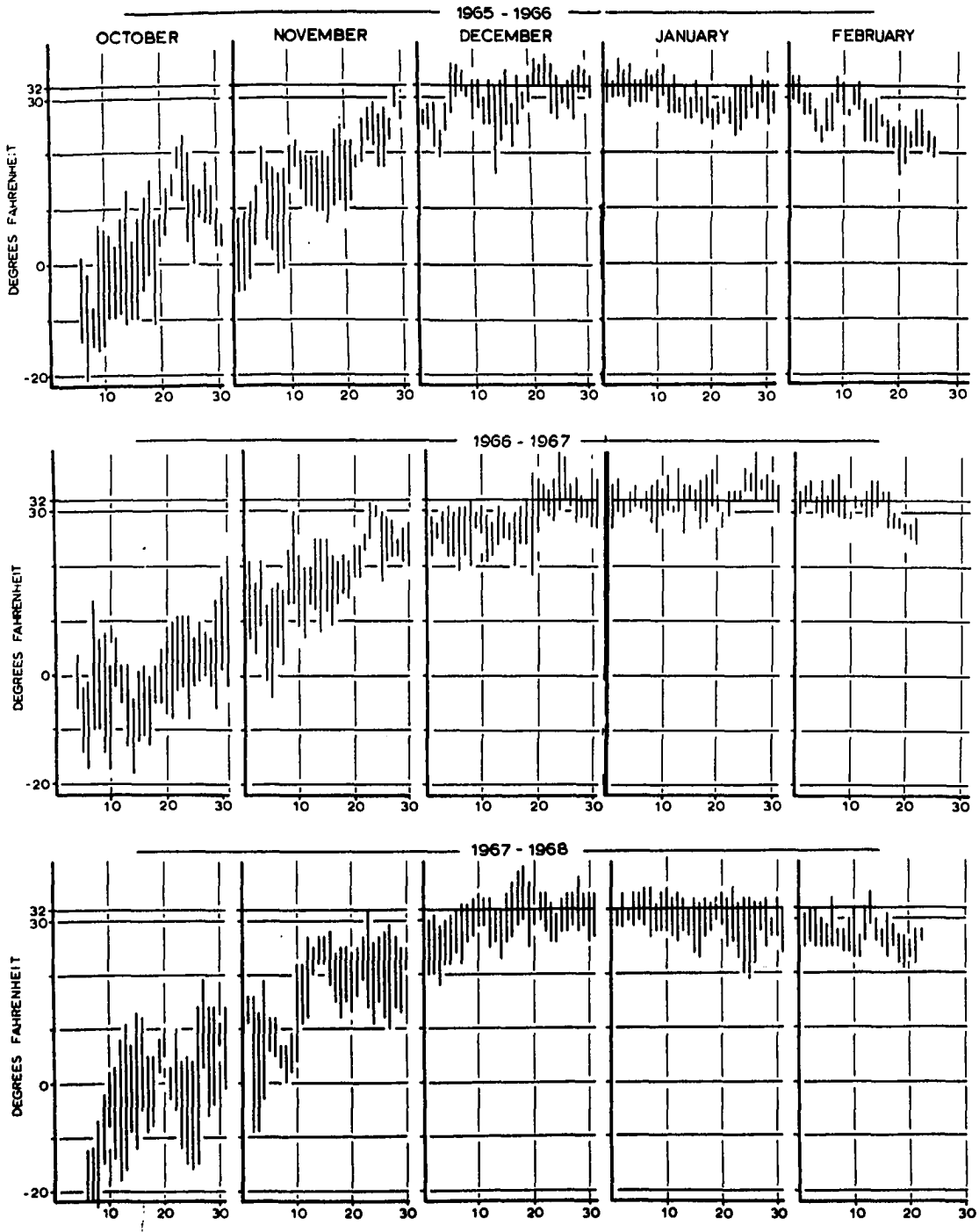
	Stage of development				
Species	Adult	Tritonymph	Deutonymph	Protonymph	Larva
S. belli	24+[b]	12-24	3-4	1 1/2-2	3/4-1
E. wisei	24-48	12-18	1-2	1/2-3/4	10-15 min
P. paulinae	12-18	3-4	1/2-1	20-30 min	5-10 min
C. gressitti	24+	12-24	12-24	12-24	4-6

[a]Room temperature, 65° - 70° F.

[b]Time is in hours unless otherwise indicated.

Other clearing agents were tried with varying degrees of success. KOH was usually too harsh and damaged the more fragile immature forms. Lactic acid acted much too slowly and a lactophenol combination sometimes used as a mounting medium was either too harsh or incompatible with other mountants.

Fig. 4. Daily maximum and minimum temperatures for three austral summer seasons (1965-1966, 1966-1967, 1967-1968) at Hallett Station, Antarctica.



DAILY MAXIMUM - MINIMUM TEMPERATURES FOR THREE AUSTRAL SUMMER SEASONS.

Fig. 5. Wind speed, wind direction and percent relative humidity recorded every three hours during three 24-hour periods, 1965-1966 austral summer season.

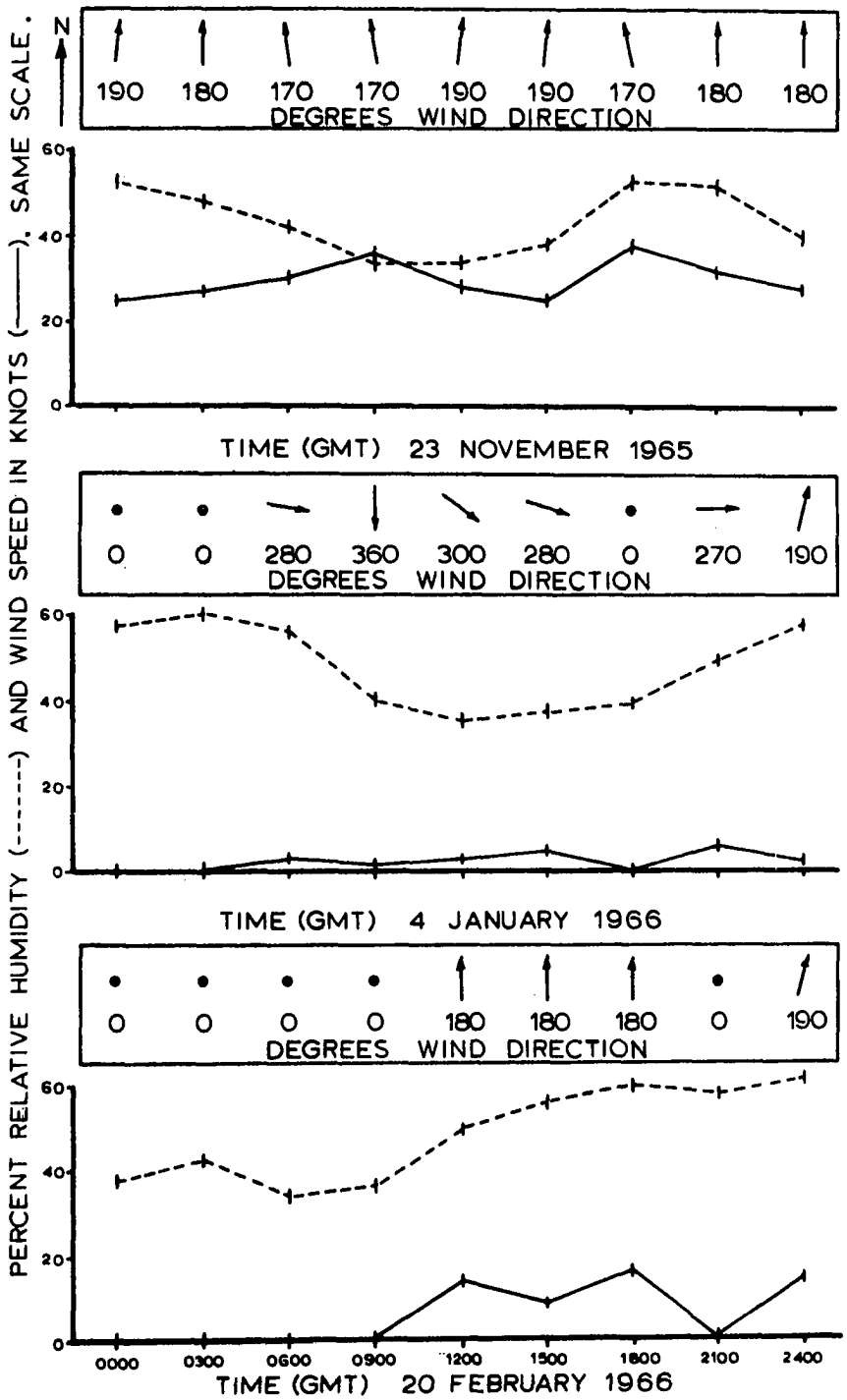

PERCENT RELATIVE HUMIDITY (-------) AND WIND SPEED IN KNOTS (———), SAME SCALE.
N
190 180 170 170 190 190 170 180 180
DEGREES WIND DIRECTION
60
40
20
0
TIME (GMT) 23 NOVEMBER 1965
0 0 280 360 300 280 0 270 190
DEGREES WIND DIRECTION
60
40
20
0
TIME (GMT) 4 JANUARY 1966
0 0 0 0 180 180 180 0 190
DEGREES WIND DIRECTION
60
40
20
0
0000 0300 0600 0900 1200 1500 1800 2100 2400
TIME (GMT) 20 FEBRUARY 1966

Fig. 6. Wind speed, wind direction and percent relative humidity recorded every three hours during three 24-hour periods, 1966-1967 austral summer season.

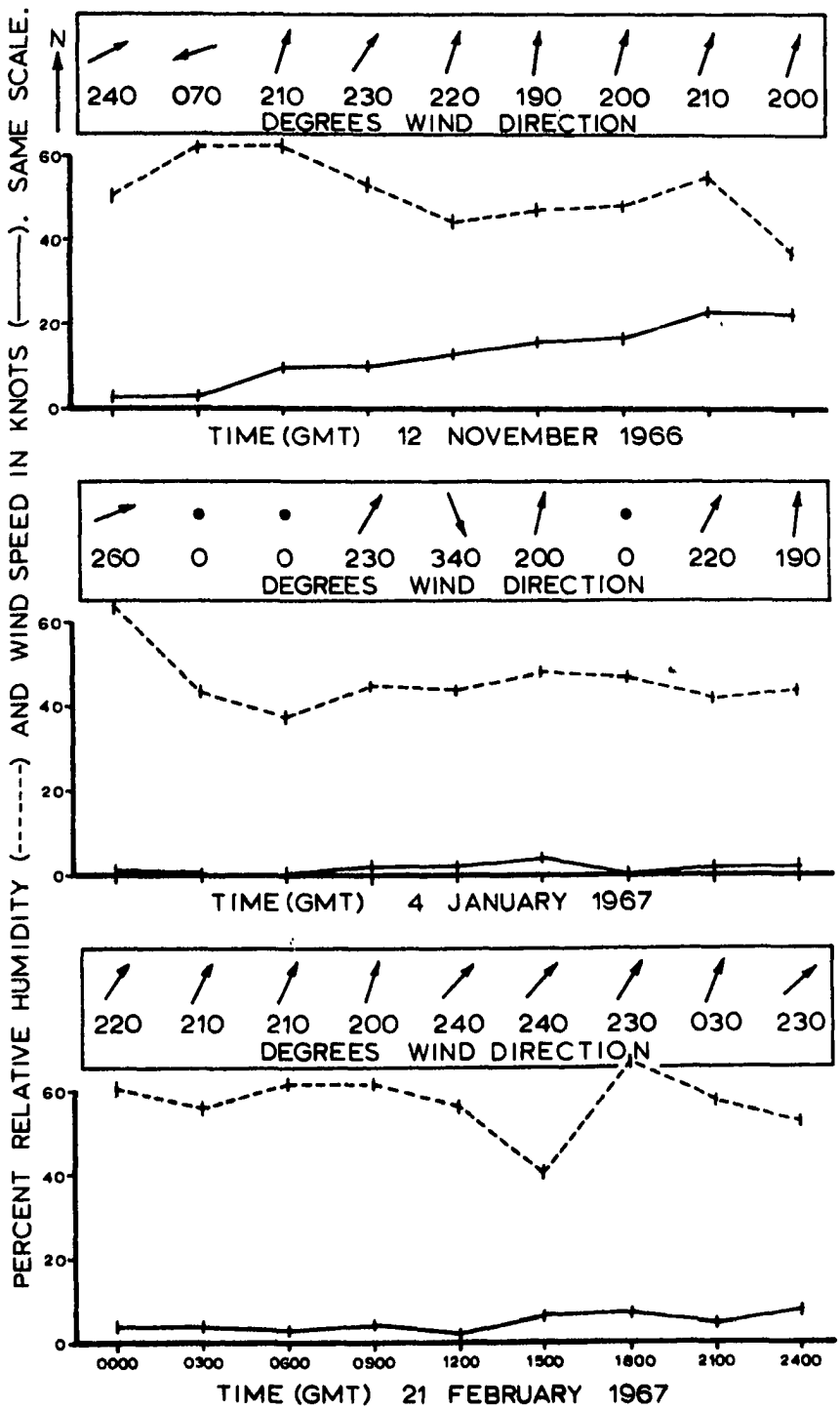
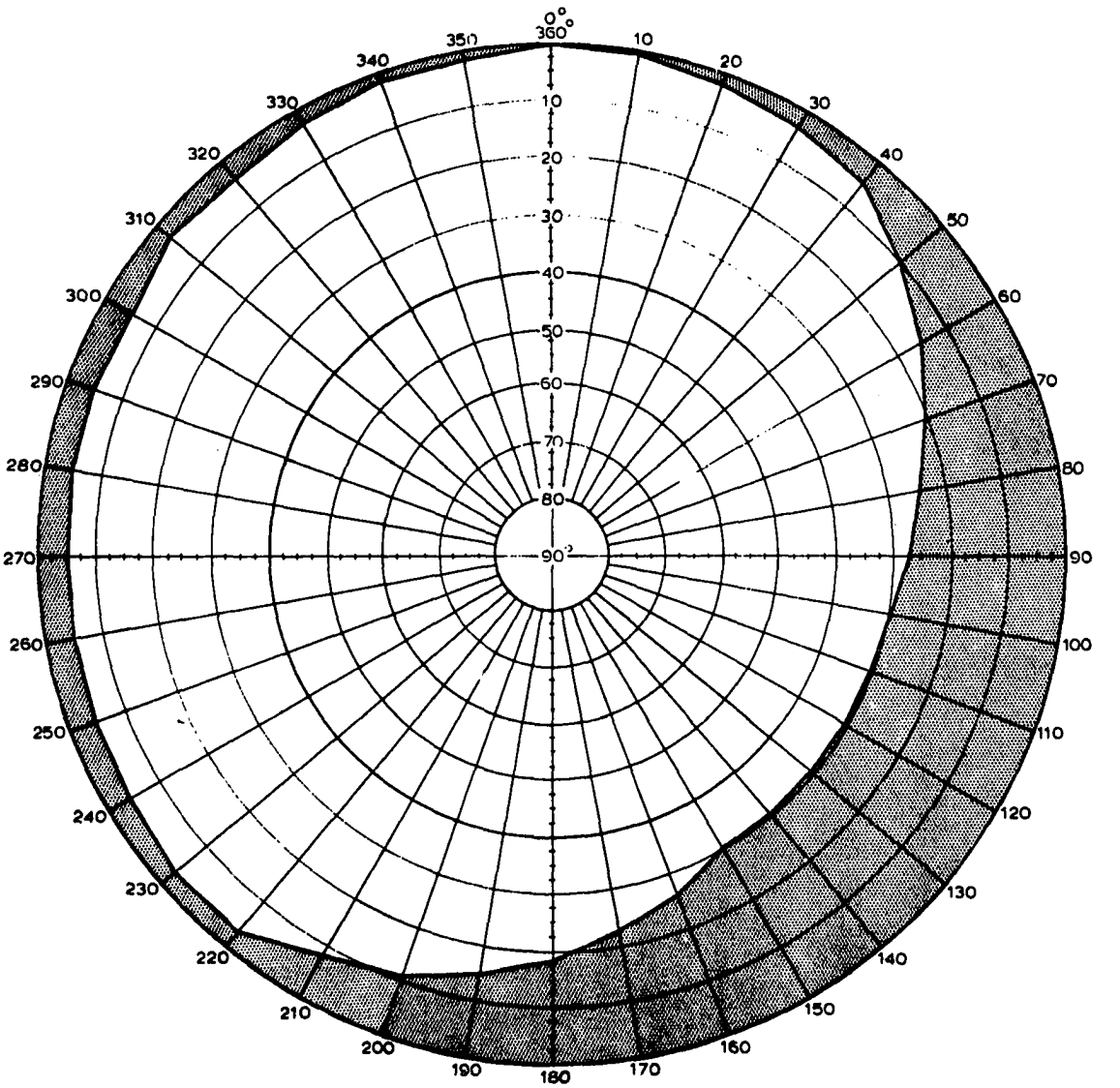

PERCENT RELATIVE HUMIDITY (------) AND WIND SPEED IN KNOTS (——). SAME SCALE.
N
240 070 210 230 220 190 200 210 200
DEGREES WIND DIRECTION
60
40
20
0
TIME (GMT) 12 NOVEMBER 1966
260 0 0 230 340 200 0 220 190
DEGREES WIND DIRECTION
60
40
20
0
TIME (GMT) 4 JANUARY 1967
220 210 210 200 240 240 230 030 230
DEGREES WIND DIRECTION
60
40
20
0
0000 0300 0600 0900 1200 1500 1800 2100 2400
TIME (GMT) 21 FEBRUARY 1967

Fig. 7. Horizon elevation in degrees at each 10-degree azimuth increment taken at research site A. Site elevation 15 m. (See Fig. 3).



HORIZON ELEVATION IN DEGREES AT EACH 10 DEGREES AZIMUTH.

A phase contrast microscope was not available for the first two seasons, therefore various stains to enhance morphological visibility were tried. Iodine was used at the rate of one drop of a 5 % alcoholic solution added to 5 ml of 80 % ethanol. The specimen was then placed in the solution for five to ten minutes before mounting. The staining quality was quite good but temporary, since the specimen faded to a colorless condition within a few hours. Other stains such as eosin, gentian violet and potassium permanganate were also tried. Results with those preparations were no more than variations of the results obtained with iodine.

Good and permanent success was obtained with chlorazol black (alcoholic).[1] It was found that a small droplet of the stain placed in 10 ml of ethanol would usually give adequate stain density. The stain was not entirely compatible with an aqueous solution, a precipitate resulting from the combination. However, the specimen usually became impregnated sufficiently to yield good light refraction which was equal to and, in some cases, surpassed phase contrast microscopy.

An attempt to utilize Canada balsam and other permanent synthetic resins was so disadvantageous that further trials were abandoned. The process was time-consuming and the specimens became so brittle in the xylene dehydration process that distortion and breakage were inevitable.

Additional temporary mounting media were subsequently used.

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[1] Edward Gurr, Ltd., London, England.

Turtox CMC-10[1] was found to be suitable for adult S. belli and C. gressitti; however, it was unsatisfactory for any of their immature stages or for other species. Since Turtox CMC-S is a staining variation of CMC-10 it also could not be used with the more delicate stages. It is believed, however, that the problem is in the length of time the specimen is left in the clearing solution. If sufficient research could be conducted, CMC-10 and CMC-S would possibly be suitable for all stages of the mites found at the Station.

The preferred mounting media were Hoyer's and de Faure's. The formulae for the two are alike in every ingredient, varying only in quantity. Each medium was found to be very usable and long-lasting. Best results were obtained when the medium was warm. The preparations nearly always produced good results for all stages of mite development. Drying of the mountant was a problem for long-term storage unless a sealing ring of enamel or plastic was placed around the edge of the cover slip.

Methocellulose and lacto-phenol were used with somewhat less desirable results. Perhaps with more time and investigation these mountants could also be developed to an acceptable degree.

Development of rearing medium

At the beginning of the first season, 1965-1966, when initial collections of mites were made in the field for species evaluation

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[1]General Biological Supply House, Chicago, Illinois.

some were retained alive in snap-cap vials. The vials were interchangeable on an aspirator mounting. S. belli was the only species that survived removal from its natural habitat in that manner. Other, more delicate species could not tolerate the change and would succumb before they could be transported the short distance to the laboratory to be placed on an artificial medium. The first attempts to keep mites alive in vitro were simply to drop the mites from the snap-cap vial onto wet filter paper in a petri dish. The petri dish was then placed in the refrigerated incubator at a temperature of 5° to 10° C. Though the temperature was satisfactory, the humidity was not. Some of the mites ran about on and under the edges of the filter paper and were readily observed to be negatively phototropic. Others became entrapped by adhesion to the water droplets on the sides and covers of the dishes.

The next attempt was to take rocks bearing mites to the laboratory and place additional mites upon the rocks in finger bowls to which water had been added. The mites moved about freely upon the rocks but eventually became trapped in the water moat. Also, water in the dishes evaporated very quickly in the frequently low humidity of the laboratory and refrigerated incubator.

An additional attempt to keep mites alive in vitro was made by sifting quantities of the coarse soil found along the talus of the skua rookery. A U.S. Standard No. 20 mesh screen (.84 mm opening) was used to collect the finer particles. The sifted soil was accumulated in sufficient quantity to place a layer approximately 3 to

4 mm deep in the bottom of the dishes. Petri dishes of 5 cm diameter were used in this trial and in all trials thereafter. Water was added until the soil particles were thoroughly wet, and any excess water was withdrawn with ink blotting paper. Mites were placed in this preparation with no long term success. Condensation was always excessive in the closed petri dishes and mold growth soon overtook the soil surface, making it uninhabitable. Neither time nor facilities permitted identification of the mold. Some samples were sterilized in an autoclave at 15 psi for ten minutes previous to wetting and placing of mites. Though mold contamination was greatly reduced the success was little or no better.

It was apparent that controlled low humidity was desirable. The night-time, low-sunlight intensities and temperatures were conducive to high humidity rates as indicated by heavy condensation within the petri dishes even though the latter were enclosed within the refrigerated incubators. To compensate for the fluctuation, the dishes were placed in glass chambers of the type used for chemical desiccation. The humidity was regulated with a saturated solution of calcium chloride within the chamber (Solomon, 1951).

With the improvement in control of relative humidity a healthier and more active condition of the mites was noted. It was possible to keep most S. belli alive for two to three weeks. By regular observation it became second nature to recognize their actions and habits. In time the creatures appeared to be starving. Food offerings of P. crispa alga and B. argentium moss were ignored. A great deal of the mites' time was spent on the B. argentium; however, no

feeding was observed. An increase in water content of the soil in conjunction with placement of ?Oscillatoria sp. algae was not tolerated by the mites.

A medium within the petri dish nearly matching the microhabitat observed under rocks in the skua rookery had become the objective. Mixtures of charcoal and plaster of Paris were tried (Table 4.) in accordance with the experience of Evans et al. (1961).

The wetting agent used was an alga rearing solution of the following formula (Bold, 1957):

$NaNO_3$	0.25 g/l
$CaCl_3$	0.025 g/l
K_2HPO_4	0.075 g/l
KH_2PO_4	0.175 g/l
$MgSO_4 \cdot 7H_2O$	0.025 g/l
NaCl	0.025 g/l
$FeCl_3$	one drop of 1 % solution

It was decided that since this solution had already been prepared to isolate cultures of filamentous algae, it should be incorporated in the solid medium to support Ulothrix and ?Oscillatoria sp. in and on the moss and surrounding areas.

The combination of charcoal 50 g, plaster of Paris 50 g, and alga rearing solution 150 ml seemed to yield an excellent surface for growing algae and moss. The air bubbles that had migrated to the surface formed small air cavities which, when dry, became small and usable hiding places for the mites. These were similar to those

Table 4. Ingredient ratios for charcoal-plaster of Paris media with alga rearing solution wetting agent

Activated charcoal, grams	Plaster of Paris, grams	Alga rearing solution, milliliters
10	90	200
20	80	180
30	70	170
40	60	160
50	50	150
60	40	140
70	30	130
80	20	120
90	10	100

cavities found on the many volcanic rocks in their natural habitat (Gless, 1967).

It was late in the 1965-1966 season and little or no progress had been made with S. belli. The larger C. gressitti were taken to the laboratory repeatedly, and failures were always registered until the petri dishes with the artificial medium were taken to the field and C. gressitti brushed into them. Information on the biology of C. gressitti learned from this early attempt was presented by Gless (1967). Additional studies are reported in the section on life cycle descriptions.

Upon my arrival at the Station in October, 1966, some of the previously prepared culture dishes were located and examined for possi-

ble continued use. The cultures had been placed in the supply cabinet before the Station had been closed several months previously. Addition of water showed that the algae and moss were still viable; however, there were no live mites.

A problem encountered with the charcoal-plaster of Paris medium was shrinkage. The medium would shrink away from the edge of the petri dish as much as three millimeters. The gap was sufficient for the wandering mites to enter and disappear. An attempt to remedy the situation was undertaken by adding a dry, fine, particle-size clay. This proved unsuccessful in every attempt since cracking and shrinkage were only increased. A second attempt was made by sifting soil with a No. 60 U.S. Standard sieve (.250 mm) and placing the fine particles in a thin layer around the edge of the charcoal-plaster of Paris medium within the petri dish. The sifted soil effectively plugged up the shrinkage gaps around the edges. However, it was found that the soil had to be sterilized prior to addition to the medium because mold was a continuous problem. Since the mites are negatively phototropic, they attempted to hide in the B. argentium and under the P. crispa. In later studies lights above the dishes in the refrigerated incubator were shut off; lights below the dishes were left on. That arrangement worked out very satisfactorily since the vegetative growth did not suffer and the mites seemed to fare better. Sterile distilled water was used to maintain the proper moisture balance, as it was believed that use of alga rearing solution would cause the nutrients to become too concentrated within the

culture. With continued observation the amount of water desired for correct moisture balance could be deduced. The factors involved were water condensate on the inside of the dish, reflective sparkle from the charcoal-plaster of Paris surface, intensity of the green color of the algae and moss and, above all, the actions of the mites.

A continuing problem was the placement of healthy, active stages of mites upon the culture medium. It was found that the most usable method was to take the pre-cooled culture dishes to the field location of large mite populations. When a rock of suitable size and with numbers of mites was held over the dish and tapped lightly with another rock, many clinging specimens were dislodged and fell the short distance onto the medium.

In the laboratory the culture dishes of mites were continuously cooled by placing them in an ice-water bath while observations with a dissection microscope were made. For further selection an Irwin Loop was dipped in sterile distilled water. The loop bearing the small droplet of water was touched to the dorsum of a selected mite, which was then transferred to another culture dish. However, the mite could not free itself from the adhesive forces of the water droplet without aid of the manipulator. The Irwin Loop had to be oriented in such a way as to drain the water off and into the medium, thus freeing the captive mite.

Success was not always attained in the methods described. E. wisei would rarely be found by tapping the rocks over the culture dishes. That species was captured with an aspirator on a snap-cap vial. When several E. wisei were collected in that manner the vial

was immediately emptied on the culture dish that had been taken to the field in a pre-cooled condition, therefore, not subjecting the mites to the hazards of being transported to the laboratory in a detrimental atmosphere. C. gressitti were later collected in the same manner. Protereunetes sp. n. were never found with any method other than flotation. Although this species is delicate and fragile, many survived the rough treatment of the soil collection method. By use of Irwin Loops previously described usable mites could be collected from the surface of the flotation and placed in suitable culture dishes. Mites of other species were also occasionally added to individual cultures from flotation collections.

Mold was a problem throughout the entire program. It was encountered every season and in every life cycle study. Daily observations were necessary. Sparse growth could be removed with a fine-pointed probe. Heavy growth was not easily controlled and generally it was observed to be indicative of excess water in the culture dish. Attempts at removal usually failed. Methods of water removal by addition of sterile soil, pieces of blotting paper and opening to air were usually ineffective. Addition of dry bits of P. crispa sometimes helped; however, the pieces were more often detrimental to the mites and a hindrance to observations.

By repeated observation and adjustments of water content in seemingly countless culture dishes, representatives of the various intermediate stages were eventually collected. Dates of collection and illustrations of morphological differences for each developmental stage are presented in the following section.

Biology and Description of Developmental Stages

The families Penthalodidae, Eupodidae and Rhagidiidae are similar in respect to reproduction, general body shape, setation, and numbers and feeding habits of their immature stages. The dorsal chaetotaxy of S. belli as seen in Fig. 8 is representative of all three families (Strandtmann, 1967).

Leg setation is less fully developed in the immature stages but provides, to some extent, good taxonomic references. A setal formula is often used to express the numbers of setae on a given leg segment, beginning with the anteromost leg and ending with the postermost. For example, the trochanteric setal formula for adult S. belli is 1,1,1,2, which indicates one seta for each of legs I, II, and III and two for leg IV. Other consistent setal numbers are afforded by the coxae and tarsi both dorsally and ventrally. Setation of the remaining leg segments is too irregular to be valuable in identifying immature stages.

External genital setae and internal genital knobs are probably the most important characters for differentiating immatures. The tritonymph of S. belli (Figs. 15 and 16) does not have completely developed genitalia, body sclerotization, leg setation or femoral divisions; however, its morphology is sufficiently developed to serve as a guide to identification of all species included in this writing.

Family Penthalodidae Sig Thor, 1933

Stereotydeus belli (Trouessart, 1902)

Penthaleus belli Trouessart, 1902. Coll. Nat. Hist. "Southern Cross" p. 225.

Chromotydeus belli Thor and Willman, 1941. Das Tierreich 71:66.

Stereotydeus belli Womersley and Strandtmann, 1963. Pacific Insects 5:458.

Figs. 8 through 17

At the beginning of the 1965-1966 season, large groups of mites were found in an area approximately 30 meters N-NE of research site B (Fig. 3). Some specimens were collected, taken to the laboratory and identified as S. belli. Attempts to keep specimens alive in culture were unsuccessful (see section on development of rearing media).

After one season of experience with culture media and at the beginning of the 1966-1967 season, more mites of the same species were collected and taken alive to the laboratory. With a dissection microscope the live mites were sorted according to size and general appearance. Adults could be clearly identified and separated from the immatures. The next smaller size was assumed to be the tritonymphal stage. When these were cleared and examined the morphology was nearly the same as that of the adult except for reduced sclerotization, reduced number of external genital setae and absence of internal genital setae. The last was in accordance with Strandtmann's manuscript, unpublished at that time (Strandtmann, 1967). On 20 October 1966 approximately 75 culture dishes

with 10 to 15 S. belli tritonymphs each were placed in an atmosphere of about 32 % relative humidity. A small clump of B. argentium with filamentous blue-green algae (?Oscillatoria sp.) growing around and among the gametophytes and patches of P. crispa and Nostoc sp. had been in culture on the surface of the charcoal-plaster of Paris medium for about six days prior to the introduction of the mites.

On 10 November 1966 three adult mites, two males and one female, were observed and collected from the culture dishes. Two exuviae were observed but were too fragile and could not be saved for demonstration. The next day many more adults were observed and at the end of the fourth day all remaining tritonymphs were removed to separate culture dishes. No feeding had been witnessed.

Routine observation for maintenance of water balance and removal of mold mycelia and dead mites was continued, and on 26 November 1966 eggs were observed in various places in several cultures. They were rose-pink and averaged 140μ in length. Neither copulation nor spermatophores had been observed.

Larva -- biology Larvae were observed feeding on the filamentous blue-green alga in their isolating culture dishes on 11 December 1966. Two of the new mites were taken for clearing and morphological studies.

Larva -- morphology Dorsal: External verticals of propodosoma and internal sacral setae of hysterosoma not present. Slight sclerotization in anterior region of propodosoma only. Epivertex pronounced and continuous with propodosomal shield. No evi-

dence of epirostral lobes. No lateral slit pores of hysterosoma. Average length 140μ. Ventral: No genital setation or knobs. A fine slit or groove in the integument at the future site of the genitalia sometimes visible with phase contrast microscopy. Anal pore terminal with 3 pairs of setae. Coxal formula: 2,1,2. No coxal pits. No trochanteric setae. Appendages: Chelicerae well developed. Terminal segment of pedipalps without rhagidial solenidion. Tarsi I with four ventral setae, tarsi II and III variable. One rhagidiform with accompanying stellate seta oblique and basal to it on tarsi I and II. Single, depressed solenidion dorsal and apical on tibiae I and II and medial on genu II. Legs IV not present.

Protonymph -- biology Approximately two weeks after the first larvae were observed, i.e., 26 December 1966, several slightly larger mites appeared in the cultures. When scrutinized for detail a fourth pair of legs could be seen. Three mites were collected and prepared for detailed study. By 7 January 1967 all remaining larvae were molted to protonymphs or considered dead and removed. Possibly the latter was a mistake since at a later date, 26 January 1967, a so-called "dead mite" was prepared for study and found to be in the process of molting. It is not known whether the larval mites that were considered dead were actually dead or in the delicate stage of ecdysis.

Feeding of protonymphs was observed only once. It is suspected that the heat and light of the microscope lamps disturbed them.

Also, they are negatively phototropic.

Protonymph -- morphology Dorsal: Chaetotaxy complete, sclerotization of propodosoma more pronounced in region of sensory setae. In most cases epivertex and propodosomal shield appear to be continuous; however, slide preparations sometimes make them appear separate. Lateral lobes of epirostrum sometimes lightly indicated. Slit pores of hysterosoma present in some specimens. Average body length 250μ. Ventral: Coxal setal formula: 2,1,2,0. No coxal pits in leg III region. Trochanteric setal formula, 0,0,1,0. Genitalia represented by one pair of internal knobs and one pair of external genital setae. No paragenital setae. Appendages: Chelicerae smooth and one-half as wide as long. Palptarsus with or without rhagidiform. Tarsi and tibiae I and II same as larval stage. All nude solenidia of tibiae and genua I and II and a new genu III solenidion are medial. Ventral setae of tarsi I, II and III are 3 pairs; tarsus IV present with 2 pairs apical. Dorsal setae of tarsi I, II and III are 3 pairs; tarsus IV, 1 pair apical. Tarsus IV with one long external lateral seta, remaining segments of legs IV nude.

Deutonymph -- biology Four mites larger than the others were found in the laboratory on 9 January 1967. There was no way to be sure if these were an advanced nymphal stage or simply large protonymphs. They did, however, appear larger, somewhat darker in color, and it was thought that additional setation on legs IV could be seen when viewed with high power of the dissection microscope. The incubator population had dwindled considerably from the

beginning of the season and the decision to take even a single mite for clearing and detailed study was difficult. When examined, the specimen showed advanced morphogenesis from which it was concluded that this mite and the others associated with it were deutonymphs.

These mites were often seen actively crawling and searching over the B. argentium clump. It is suspected that they were feeding on the filamentous blue-green alga growing among the gametophytes.

Deutonymph -- morphology Dorsal: Sclerotization smooth to punctate, without sculpturing, increased to occupy entire propodosomal shield. Sensory setae twice as long as the remaining dorsal setae. Epivertex distinct from central epirostral lobe. Lateral epirostral lobes much in evidence. Hysterosoma slit pores present, but difficult to see. Average body length 275μ. Ventral: Coxal setal formula: 2(3),1,3(4),2.[1] Coxal pits of epimera III not present. Trochanteric setal formula: 1,1,1,0. Genitalia represented by 2 pairs of internal knobs and 2 pairs of external genital setae. Two pairs of paragenital setae present. Anal pore and setae same as adult (Womersley and Strandtmann, 1963). Appendages: Chelicerae smooth and well developed. Palptarsus with or without rhagidiform seta. Two rhagidiforms and accompanying basal stellate setae dorsal on tarsi I and II. Apical depressed solenidion dorsal on tibiae I

[1]The numbers in parenthesis of the setal formula indicate that number can be present on one or both legs at the same time.

and II as in protonymph. Nude solenidia on tibia I apical, genu I medial, tibia and genu II medial, tibia and genu II medial or apical, tibia III apical, genu III basal, tibia IV basal and genu IV none. Dorsal setae of tarsi I, 4 pairs; II with 2 pairs and one of a third pair may or may not be present; III, 2 pairs; IV with 2 pairs plus a single dorso-lateral seta one-and-one-half times as long as the others. All tarsi have 3 pairs of ventral setae.

Tritonymph -- biology Because of the high mortality rate and the difficulty in maintaining a suitable environment in vitro, many single-mite cultures were consolidated. Approximately 20 culture dishes remained active of which most had one or two mites, a few with three or four.

Seventeen days after collection of the single deutonymph, the so-called "dead mite"[1] was collected on 26 January. When it was cleared and mounted, the nymphal skin with deutonymph genital setae on the genital flaps could be clearly seen surrounding the body of a mite with advanced morphogenesis. It was concluded then to be a mistake to discard the "thought-to-be-dead" mites.

From that point on the immobile mites were left as found in the culture. Their position was identified by placing a short piece of plastic bristle from a typewriter brush in the surface of the medium with a forceps. While this did not mark the mite per se the bright

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[1] See section on biology of S. belli protonymph, p. 60 and 61 of this section.

color was easily seen and served in helping to determine if any movement had taken place. More than half of the mites identified in this manner were actually dead.

Tritonymphs were observed one time to be actively feeding upon the P. crispa, though they spent most of their time in and around the B. argentium clump. The blue-green alga was frequently replenished by placing a small pinch of the algal filaments on the moss. The alga supply was kept in a test tube of alga-rearing solution at the same temperature as that of the mite cultures.

On 30 January 1967 two mites in one dish were observed to be dragging exuviae from legs IV. One was taken and prepared for study. Its body structure was the same as the "dead mite" taken four days earlier. Two days later three other dishes had freshly molted mites in them. Subsequently, an additional live mite was taken for study. Three more that had died after molting were also prepared for study.

Tritonymph -- morphology Average body length 475μ. Sensory setae slightly more than twice as long as remaining dorsal setae. Epivertex prominent, lateral epirostral lobes pronounced. Sclerotization of propodosoma with sculpturing in triangular region of sensory setae and epivertex. Dorsal chaetotaxy and slit pores same as deutonymph. Ventral: Coxal setal formula: 3,1,3(4),3(4). Coxal pits of legs III present. Trochanteric setal formula: 1,1,1,1,(2). Genitalia with 2 pairs of internal knobs and 3 pairs of external setae, sometimes four setae on one flap. Five pairs of paragenital setae; anal pore and setae same as deutonymph.

Appendages: Chelicerae smooth, well developed and extending to base of palptarsus. Rhagidiform seta on palptarsus sometimes present. Tarsi I and II with three well developed rhagidiforms and accompanying dorsal basal seta. Tibia I with apical and lateral depressed solenidion as in deutonymph. Tibia II with apical globose solenidion in a pit. Nude solenidia: Tibia I, apical; II, apical; III, apical (sometimes medial); IV, basal to medial; genu I, apical (sometimes medial); II, medial (sometimes apical); III, medial; IV, none. Dorsal setae of tarsi I and II are 3 pairs; III and IV, 2 pairs each plus a single seta twice the length of the others. Ventral setae of the tarsi are: I, 5 pairs; II, III and IV, 4 pairs each.

Biology summary -- S. belli Feeding habits of the immature stages of S. belli are still relatively unknown. Larvae were observed feeding on filamentous blue-green alga (?Oscillatoria sp.) several times.

Protonymphs were only observed feeding once. Deutonymphs were never observed to feed though it is obvious from their enlarged and dark-colored abdomens that food was being acquired. Tritonymphs were seen to eat P. crispa once; however, the filamentous blue-green alga seemed to be preferred. They were never actually observed to be feeding upon it but bits of the growth would disappear from one observation to the next. In an effort to supply better food, samples of a golden-brown diatom (Navicula sp.) were placed in several cultures. The diatom was taken from large masses growing along the freshets of melt water in the skua rookery (Fig. 18). Though the

mites were never observed feeding on the diatom, cleared specimens often contained diatoms within them.

By mid-February it became doubtful that any tritonymph would molt to adult before the end of the season. Most immatures found in nature were still deutonymphs. The living mites in culture became reduced to approximately eight in six cultures. The season was ending and time to close the station was near. The laboratory was to be shut down on 24 February. One last look at the cultures was made on 22 February to make adjustments. One mite was found to be recumbent and, since it would be many days before the cultures could be observed again, the decision was made to prepare that specimen. It was found to be a tritonymph molting to adult form. The adult genitalia can be seen within the tritonymphal skin (Slide no. IH79-67, Gless collection). Other morphological characters conform to the description given by Womersley and Strandtmann (1963).

Upon arrival at Iowa State 17 days later the mites in the cultures were dead. These were cleared, mounted for study and subsequently found to be tritonymphs.

Days spent in each stage are indicated a follows:

Stage	Date placed in culture or molting observed	Days
Tritonymph	20 October 1966	
		22
Adult	10 November 1966	
		16

Egg	26 November 1966	
		15
Larva	11 December 1966	
		15
Protonymph	26 December 1966	
		15
Deutonymph	9 January 1967	
		21
Tritonymph	30 January 1967	
		23
Adult (F-2)	22 February 1967	

Samples taken from the field two days prior to closing the station indicated that 90 % of the immatures were in the tritonymphal stage. Deutonymphs constituted most of the remainder. Some protonymphs were collected, but no larvae were present.

Tritonymphs were collected in large numbers in October and only one mite from eight tritonymphs in vitro (12.5 %) matured to adult. It is therefore assumed that the tritonymphal or earlier stage is the condition in which most S. belli spend the winter. It is quite possible that more maturing takes place during the early winter months since there are many warm days during March and April before it becomes extremely cold. However, the numbers of mites in this study are too small to compare with any in vivo samples that might be taken at the beginning of the next season.

Morphology summary -- S. belli Dorsal chaetotaxy is incomplete in the larva and complete in all nymphal stages. There is a gradual transition from the smooth anterior of the larva to the pronounced trilobed and sclerotized condition of the adult propodosoma. The epivertex with sensory setae is well developed in all stages. The dorsal slit pores are present but difficult to see in the nymphal stage. They could not be demonstrated in the larval stage.

Comparisons of body size averages measured in microns from tip of the epivertex to posterior of hysterosoma are as follows:

Larva	140
Protonymph	250
Deutonymph	275
Tritonymph	475
Adult	550

A summary of coxal setal formulae is:

	I	II	III	IV
Larva	2	1	2	-
Protonymph	2	1	2	0
Deutonymph	2(3)	1	3(4)	2
Tritonymph	3	1	3(4)	3(4)
Adult	3	1	4	3

Coxal pits in the region of epimera III do not appear until the tritonymphal stage.

The trochanteric setae of all stages of development are as follows:

	I	II	III	IV
Larva	0	0	0	-
Protonymph	0	0	1	0
Deutonymph	1	1	1	0
Tritonymph	1	1	1	1(2)
Adult	1	1	1	1

Probably the most important morphological characters for differentiating immature stages of S. belli are the presence or absence of external genital setae, internal genital knobs, and paragenital setae. Their numbers are compared as follows:

	Pairs of setae on flaps	Pairs of paragenital setae	Pairs of internal genital knobs
Larva	-	0	0
Protonymph	1	0	1
Deutonymph	2	2	2
Tritonymph	3	5	2
Adult	6	8 to 10	2

Immature stages do not have internal genital setae. Reproductive structures such as a sperm sac as seen in adult males have never been observed.

Rhagidial solenidia on tarsi I and II and depressed solenidia on tibiae I and II also increase in numbers with developmental

stages. Their distribution is as follows:

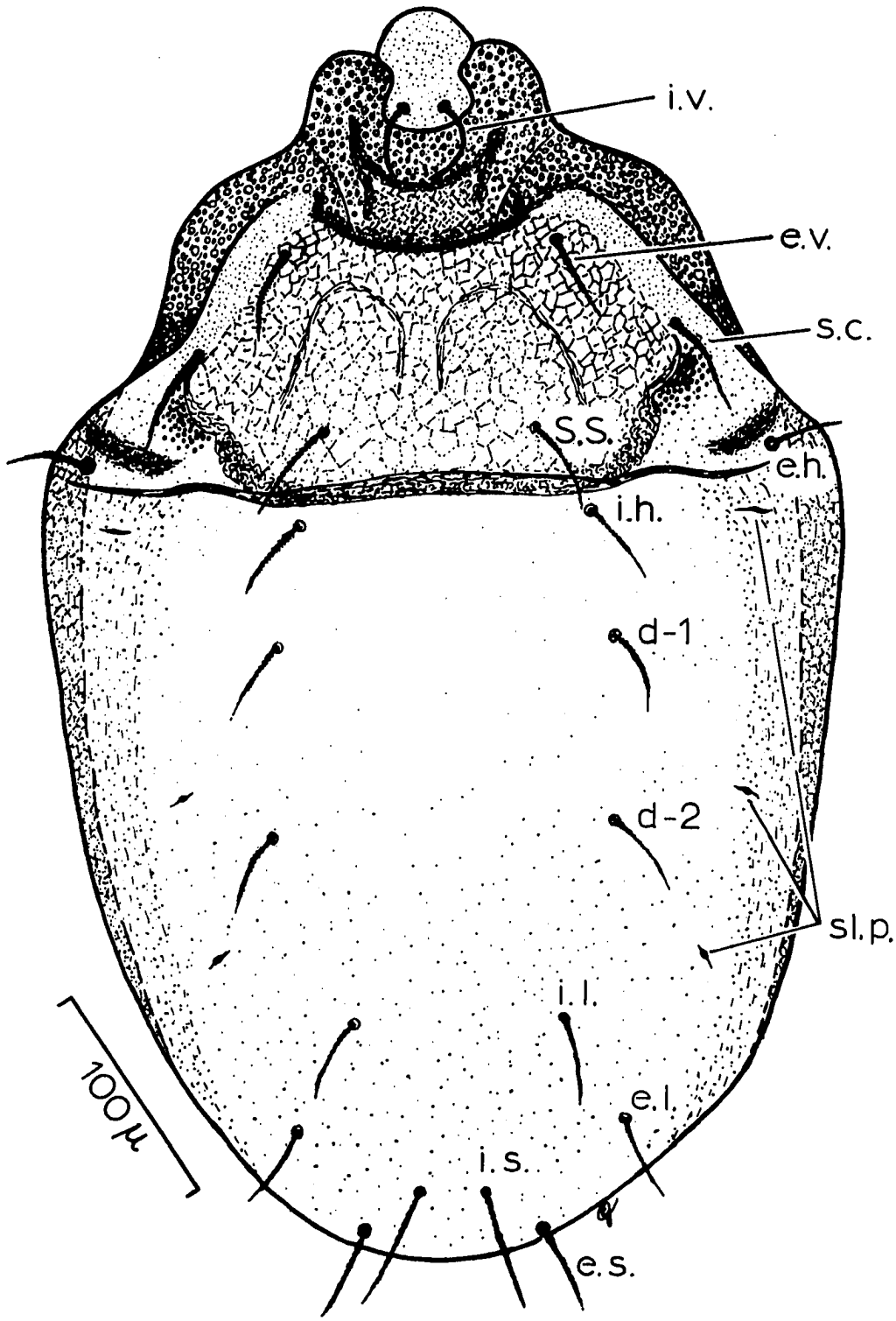
	Tar I	Tib I	Tar II	Tib II
Larva	1	1	1	1
Protonymph	1	1	1	1
Deutonymph	2	1	2	1
Tritonymph	3	1	3	1
Adult	3	1	3	1

Positions of nude solenidia are compared as follows:

	Tib I	Tib II	Tib III	Tib IV	Gen I	Gen II	Gen III	Gen IV
Larva	A[1]	A	0	-	0	M	0	-
Protonymph	M	M	0	0	M	M	M	0
Deutonymph	A	M/A	A	B	M	M/A	B	0
Tritonymph	A	A	A/M	B	A/M	M/A	M	0
Adult	A	A	B/M	M	A	A	M	0

[1] A is apical, B is basal, M is medial, M/A indicates more mites were found with the solenidion medial than apical, and A/M is vice versa.

Fig. 8. Adult dorsal chaetotaxy of families Penthalodidae, Eupodidae and Rhagidiidae. Names of structures: i.v., internal vertical; e.v., external vertical; sc., scapular; S.S., sensory seta; e.h., external humeral; i.h., internal humeral; d-1 and d-2, dorsal 1 and dorsal 2; i.l., internal lumbar; e.l., external lumbar; i.s., internal sacral; e.s., external sacral; sl.p., slit pores.



IDIOSOMA. Stereotydeus belli Womersley and Strandtmann
Family Penthalodidae

Fig. 9. Dorsal and ventral aspects of Stereotydeus belli Womersley and Strandtmann, larva.

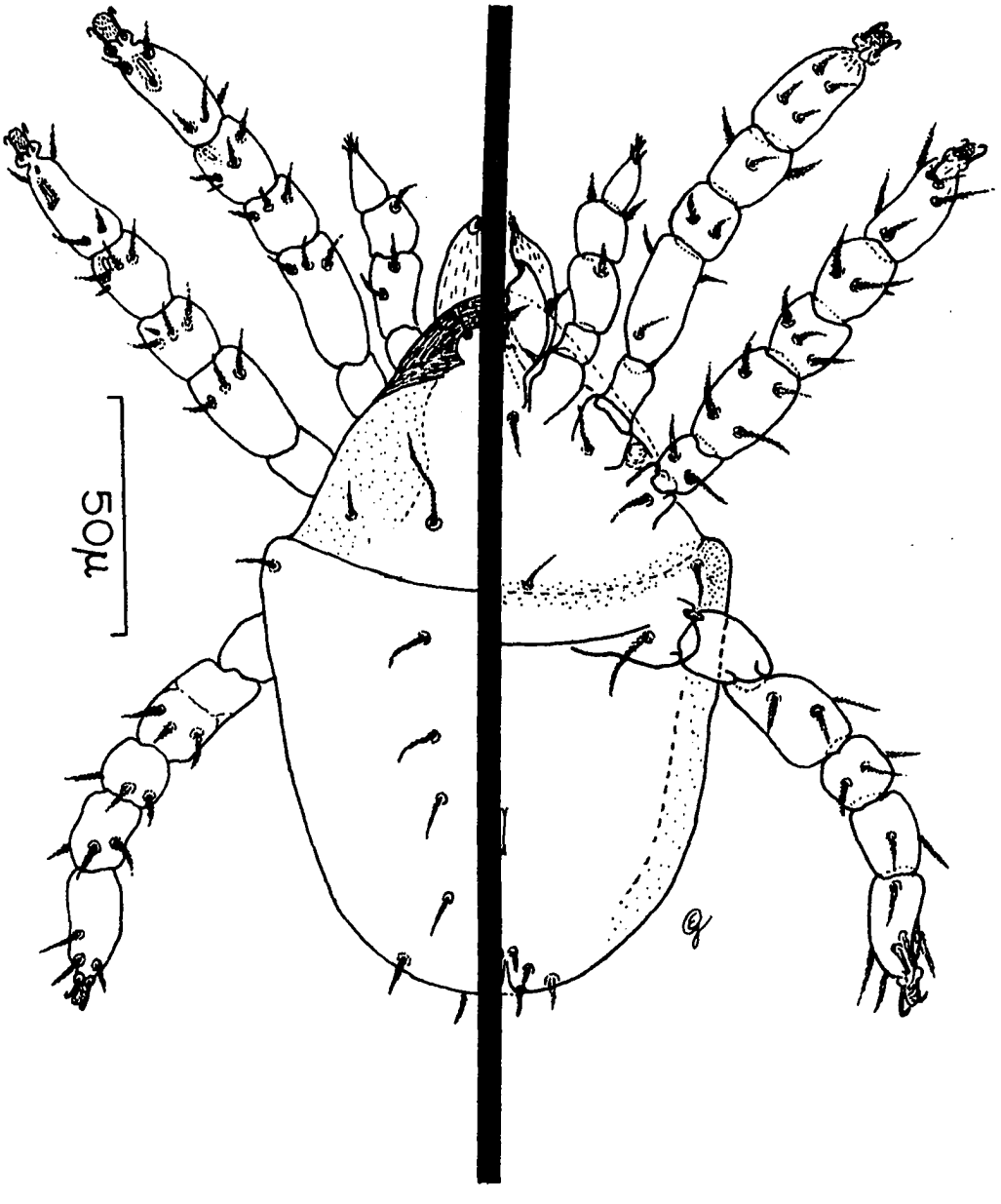
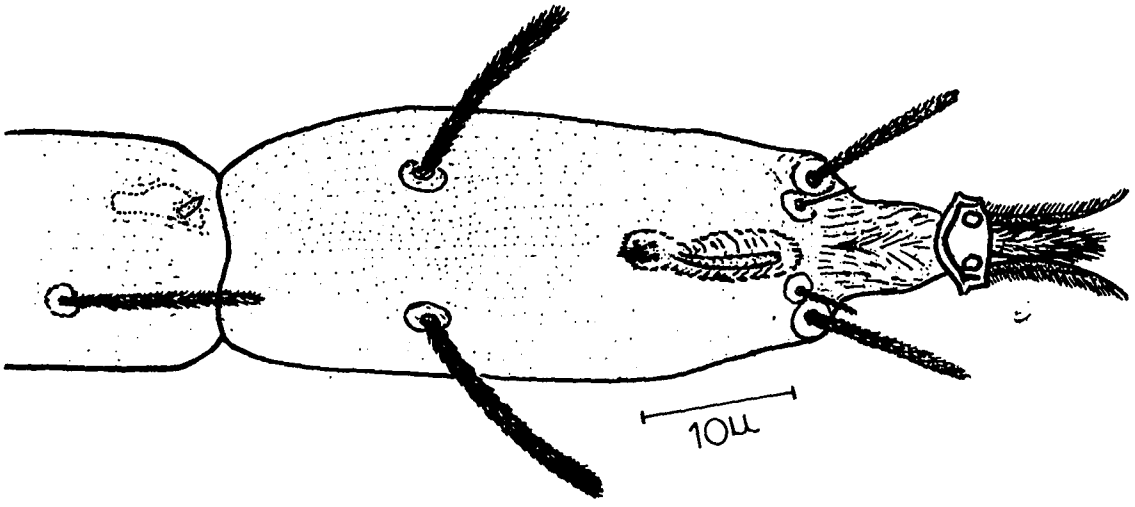

50μ

Fig. 10a. Tarsus I. Stereotydeus belli Womersley and Strandtmann, larva, dorsal.

Fig. 10b. Tarsus I. Stereotydeus belli Womersley and Strandtmann, larva, ventral.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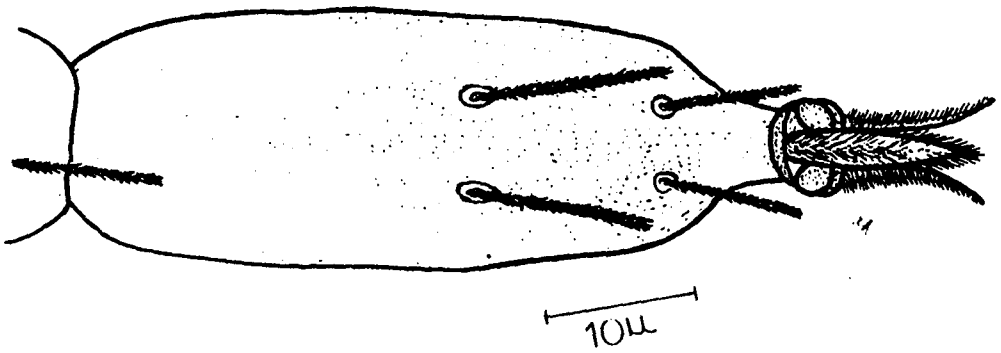
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Fig. 11. Dorsal and ventral aspects of Stereotydeus belli Womersley and Strandtmann, protonymph.

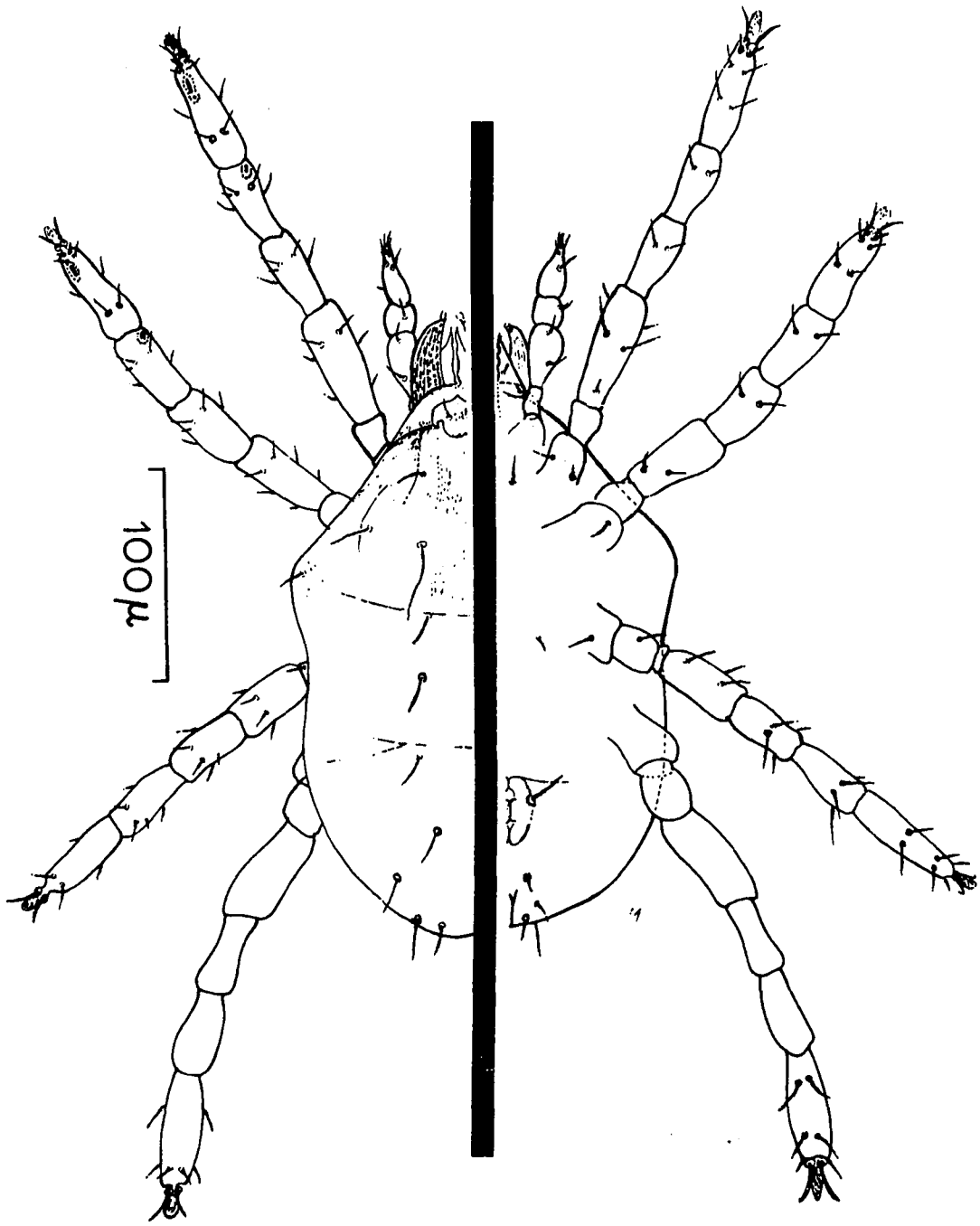
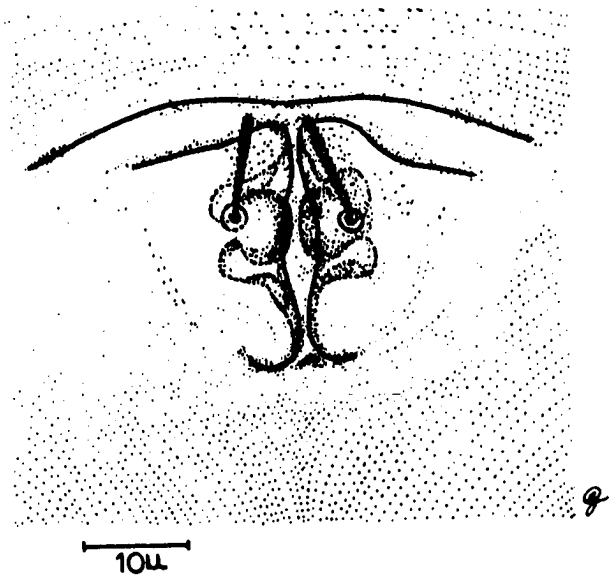

100μ

Fig. 12a. Genital field, Stereotydeus belli Womersley and Strandtmann, protonymph.

Fig. 12b. Tarsus I. Stereotydeus belli Womersley and Strandtmann, protonymph, dorsal.

Fig. 12c. Tarsus I. Stereotydeus belli Womersley and Strandtmann, protonymph, ventral.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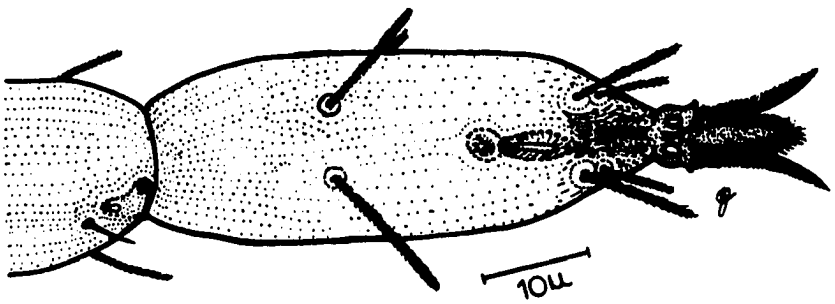
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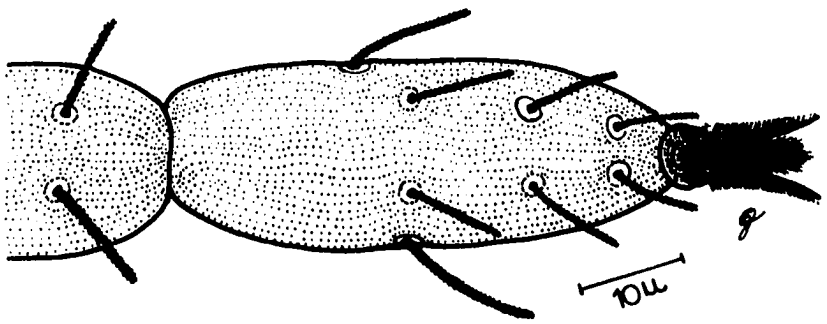
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Fig. 13. Dorsal and ventral aspects of Stereotydeus belli Womersley and Strandtmann, deutonymph.

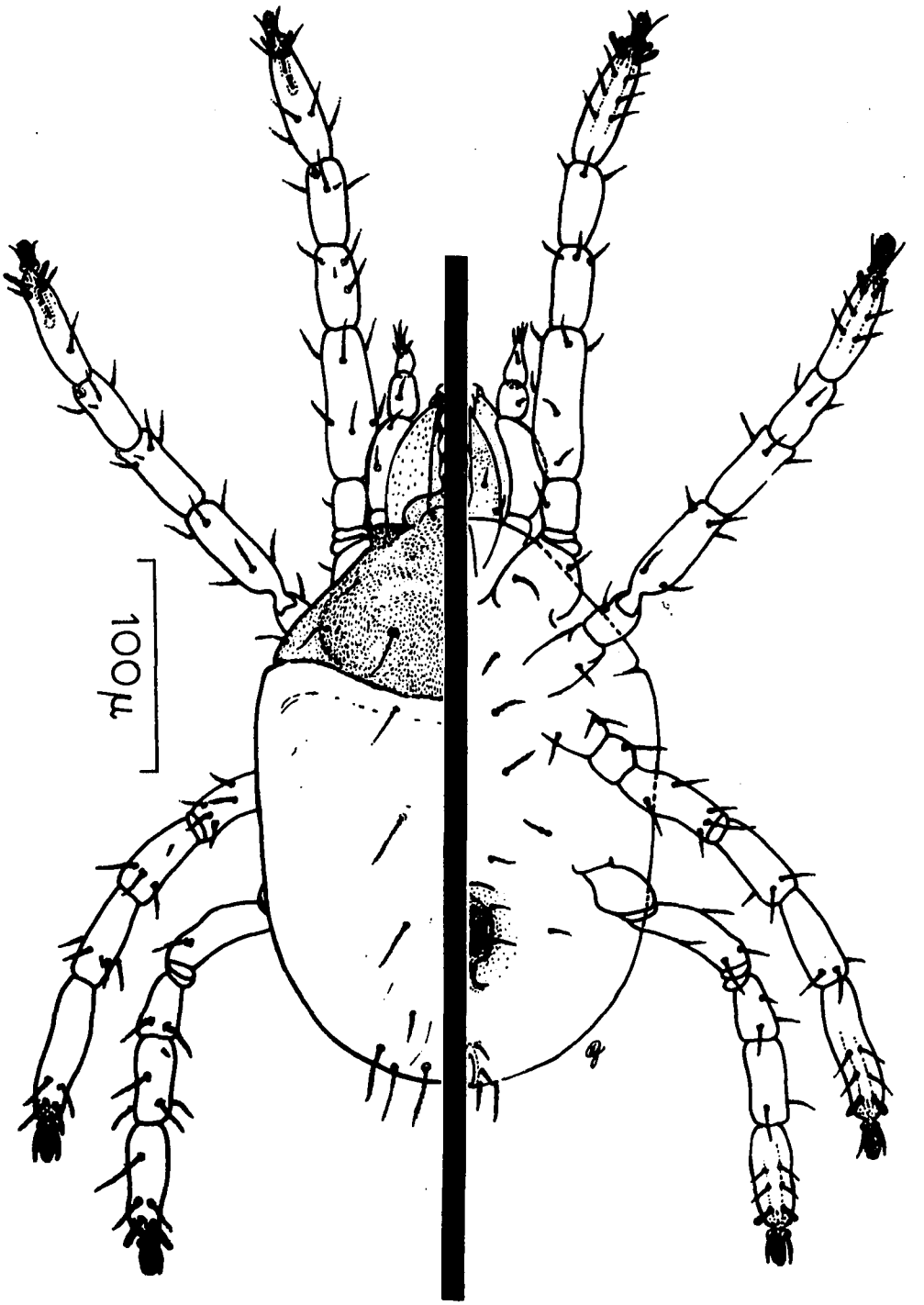
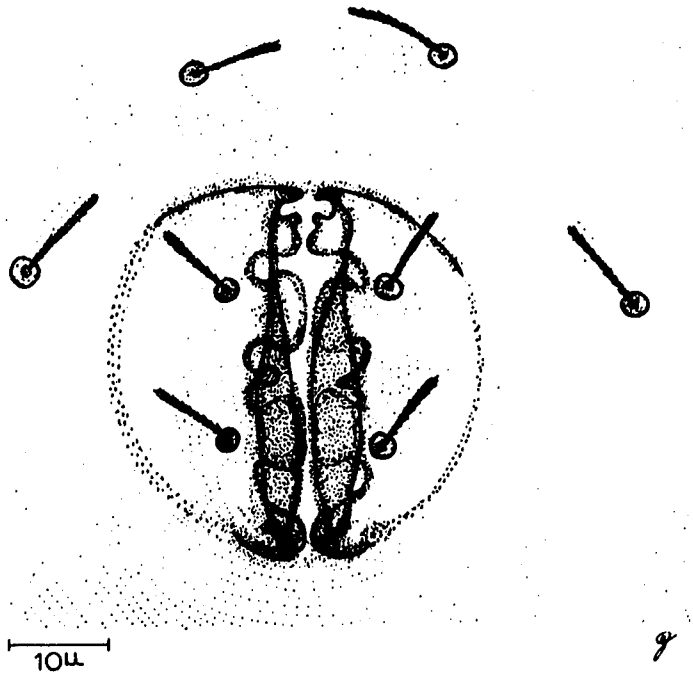

100 µ

Fig. 14a. Genital field, Stereotydeus belli Womersley and Strandtmann, deutonymph.

Fig. 14b. Tarsus I. Stereotydeus belli Womersley and Strandtmann, deutonymph, dorsal.

Fig. 14c. Tarsus I. Stereotydeus belli Womersley and Strandtmann, deutonymph, lateral.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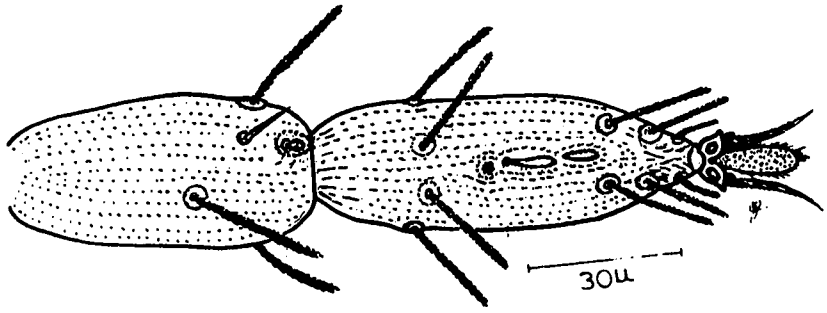
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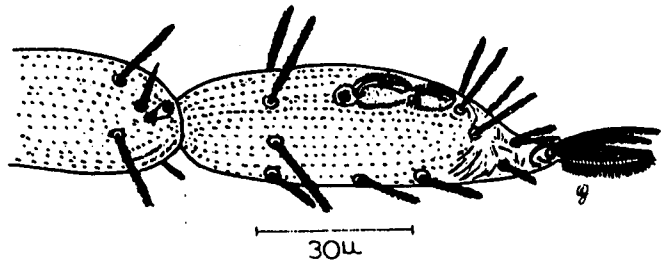

30µ
♀

Fig. 15. Dorsal and ventral aspects of Stereotydeus belli Womersley and Strandtmann, tritonymph: i.r., internal rostral seta; e.r., external rostral seta; g.s., genital seta; pg.s., paragenital setae; a-1, a-2, a-3, anal setae; n.s., nude seta.

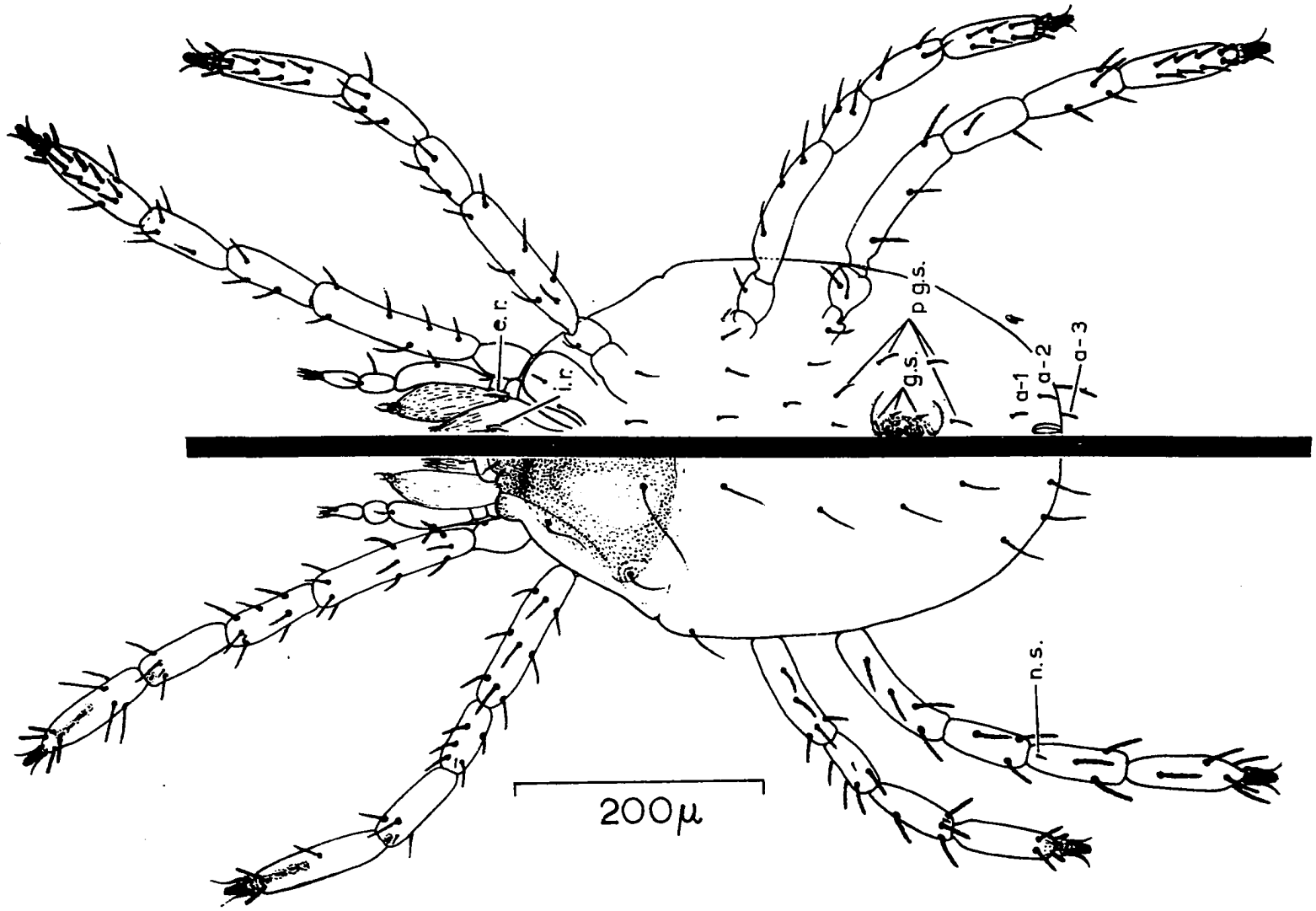

e.r.
i.r.
p.g.s.
g.s.
1 a-1
a-2
a-3
n.s.
200μ

Fig. 16a. Genital field, Stereotydeus belli Womersley and Strandtmann, tritonymph.

Fig. 16b. Tarsus I. Stereotydeus belli Womersley and Strandtmann, tritonymph, dorsal: n.s., nude seta; dp.s., depressed solenidion; rhg., rhagidiforms.

Fig. 16c. Tarsus I. Stereotydeus belli Womersley and Strandtmann, tritonymph, lateral.

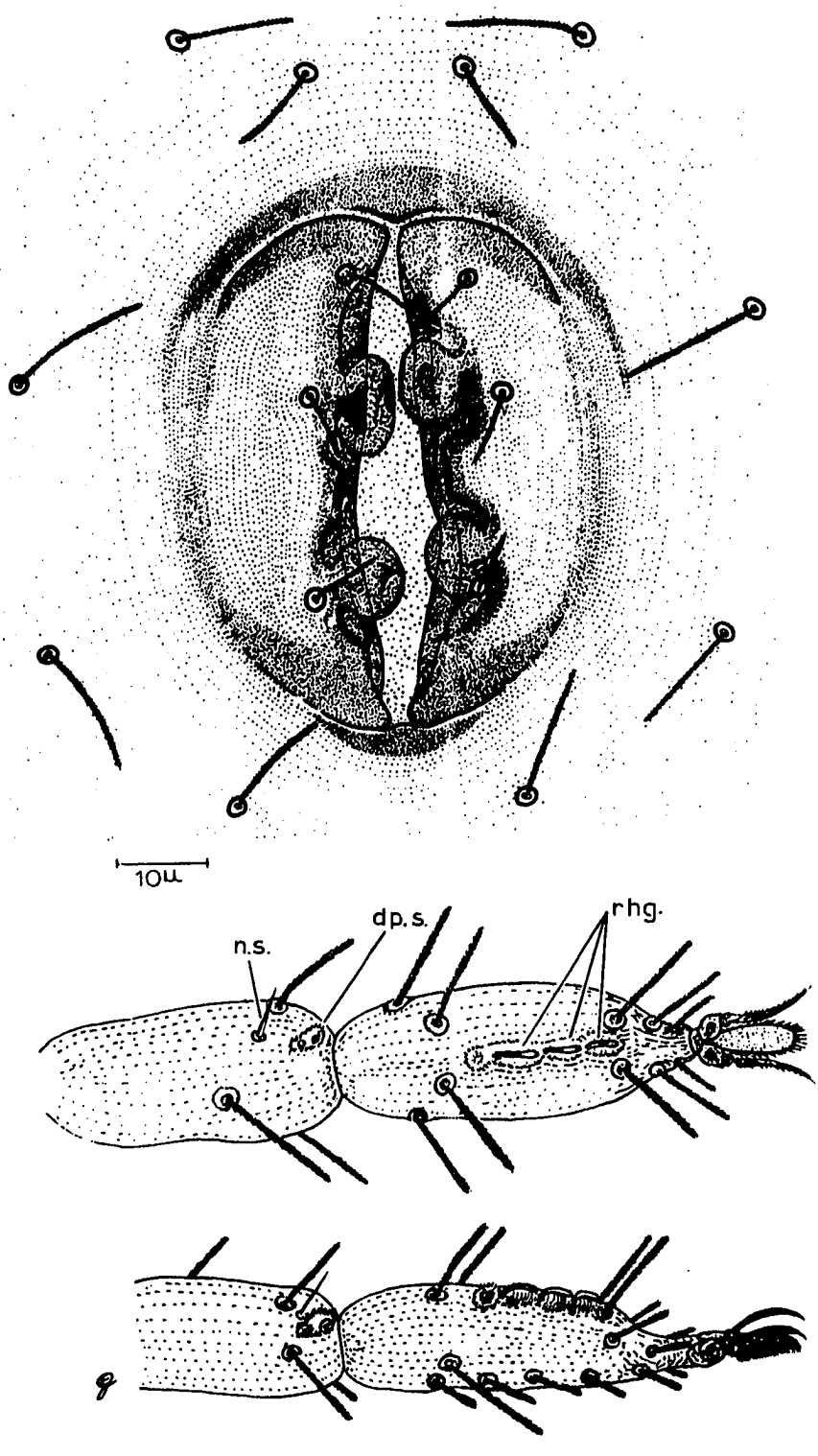
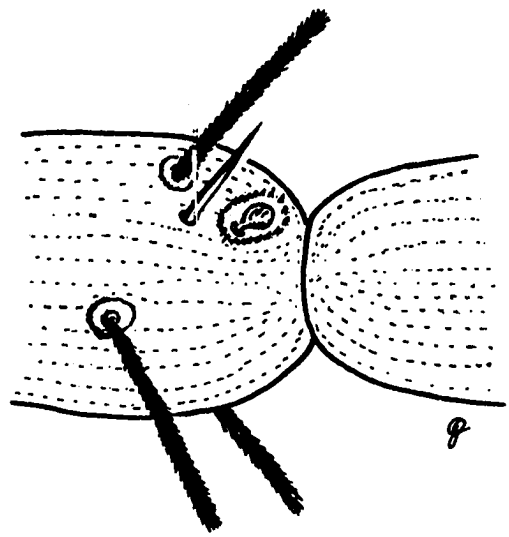

10u
n.s.
dp.s.
rhg.
g

Fig. 17a. Junction of tarsus and tibia I, Stereotydeus belli Womersley and Strandtmann, tritonymph. Dorsal view showing depressed globose and nude solenidia.

Fig. 17b. Junction of tarsus and tibia II, Stereotydeus belli Womersley and Strandtmann, tritonymph. Dorsal view showing depressed globose and nude solenidia.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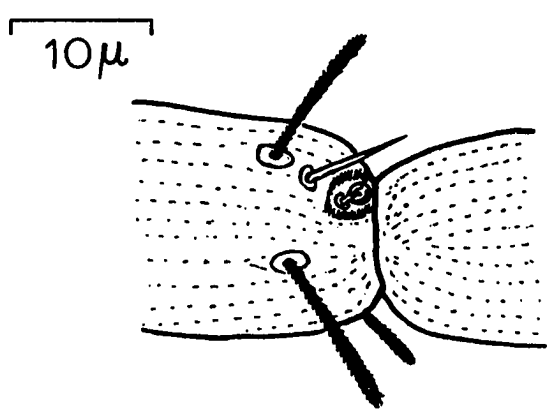
10μ

Fig. 18. A heavy growth of golden-colored diatoms, genus Navicula, found in many places in the study area.

Family Eupodidae C. L. Koch, 1842

Eupodes wisei Womersley and Strandtmann, 1963. Pacific Insects 5:451.

Figs. 19 through 23

In an area approximately 15 m N-NE of research site C, (Fig. 3) the coarse talus from the cliff of Hallett Peninsula has fanned out into part of the study area. The lower extreme or terminal area of the fan is the annual nesting site for numbers of South Polar skuas. At the close of the 1965-1966 season E. wisei was found in small numbers on the under sides of rocks in that portion of the study area. The most frequent collections were in areas immediately below the vacant nest sites of previous years. At a later time these mites were found under the edges of much larger rocks at a depth suitable to their environmental requirements.

Tritonymphs of E. wisei were found to have 3 pairs of external genital setae as were found in S. belli. The enlarged femora IV clearly distinguish them from all other species found in the study area.

Early attempts to take E. wisei to the laboratory failed. The mites could not withstand the detrimental atmosphere of a snap-cap vial and were much more difficult to work with than was S. belli since only two or three at a time could be located on the under surface of any given rock. The mites are saltatorial as is indicated by their enlarged femora IV, and attempts to keep them confined in

a culture dish while trying to dislodge others from a rock were discouraging. It was found later that a snap-cap vial containing a small piece of moist blotting paper (ca. 1 cm^2) could be utilized to collect greater numbers. When sufficient numbers were collected they were then transferred to pre-cooled culture dishes that had been prepared with growths of algae and moss as in preparation for S. belli. Sorting for uninjured tritonymphs was conducted at a later time in the laboratory with techniques previously described.

Attempts at collecting E. wisei in the early parts of the season failed. In mid-November approximately 38 tritonymphs were placed in culture. The first molts of these were on 27 and 28 November. At that time there were only 12 newly molted adults which later died (2 December). Adults in larger numbers were collected from the field for replenishment of the cultures.

On 19 December the first ivory-colored eggs were observed. They averaged 135μ in length. As with S. belli, neither copulation nor spermatophores were observed.

Larva -- biology Fourteen days after the first egg was seen the first larva was observed (2 January). After an additional six days sufficient numbers of larvae were available to take several for clearing and morphological studies. Their color was ivory with the exception of the idiosoma which was greenish-gray with a white longitudinal stripe.

Larva -- morphology Over-all length 180μ to 190μ. Dorsal: Epivertex distinct from propodosoma. A dividing suture present as a slight cuticular fold between the propodosoma and the hysterosoma. Dorsal chaetotaxy complete. Sensory setae twice the length of remaining setae on propodosoma. Internal and external sacral setae ventral. Sclerotization lacking in most cases, but weakly evident in the epirostral shoulder region anterior and lateral to the epivertex. Ventral: Trochanteric setae none. Coxal setae claviform, formula: 2,1,2. Epimera barely evident. Anal pore ventral with 3 pairs clavate setae. Appendages: Pedipalps four-segmented, one-half length of legs I. Chelicerae membranous and longitudinally punctate, entirely divided, 1 pair lightly pilose setae basal to delicate cheliceral claws. Submental rostrum three-fourths length of chelicerae with 1 pair of subapical slightly pilose setae. Rhagidiforms: One on each of tarsi I and II. No seta associated with rhagidiform on tarsus II. Ventral setae of tarsus I, 3 pairs; tarsi II and III, 2 pairs. No rhagidiforms on tibiae. Legs IV absent.

Protonymph -- biology Ten days after the first larva was observed the first protonymph was recognized (12 January). Additional protonymphs were not seen until the 18th day (20 January). On 22 January the protonymphs were seen to feed briefly on the filamentous alga growing in and around the clump of B. argentium. Diatoms were washed from the B. argentium and identified as genus Navicula. It is suspected that the protonymphs were feeding upon the

diatoms as well as on the alga. When freshly molted, the protonymphs' colors were nearly the same as those of the larvae; however, after feeding the colors changed to a deeper yellow to orange in all body areas except the idiosoma which remained approximately the same.

Immediately after the protonymphs were seen to feed, the cultures were consolidated with those having superior quality algae and moss growths. The total number of specimens was 19.

Protonymph -- morphology Average length 210μ. Epivertex same as larva. Dividing suture between pro- and hysterosoma present. Dorsal chaetotaxy complete. Sensory setae three times as long as remainder of setae on propodosoma and equal in length to setae of hysterosoma. Epirostral shoulder region weakly sclerotized. Ventral: Trochanteric setal formula: 0,0,1,0. Coxal setae claviform formula: 3,1,2,0. Epimera easily seen, extending nearly to mid-ventral line. Anal pore ventral with 3 pairs clavate setae. Genital field represented by 1 pair of internal knobs and 1 pair of external genital setae. Appendages: Chelicerae lightly punctate. One small pair of nude setae proximal to cheliceral claws and difficult to differentiate. Submental rostrum with 1 pair of slightly pilose setae subapical. Tarsi I and II with one rhagidiform subtended with small st stellate seta on tarsus I, and nude seta on tarsus II. No rhagidiforms on tibiae I or II. Ventral setae of tarsus I, 3 pairs; tarsi II, III and IV with 2 pairs. Tarsus IV with one long seta dorsal and 1 pair apical-lateral; remaining segments legs IV nude. Femora IV enlarged, division lightly indicated ventrally.

Deutonymph -- biology One deutonymph was collected on 26 January. By 10 February nine more had molted, one of which was collected for microscopic examination. The total number of remaining E. wisei culture specimens was eight. The mites did not seem healthy. Other sources of food were provided but were rejected. The colors remained somewhat similar to the protonymph or slightly darker.

Deutonymph -- morphology Average length 230μ. Epirostral shoulders evident and lightly sclerotized. Epivertex distinct. Division between pro- and hysterosoma slightly indicated. Sensory setae long and filiform. External humeral setae three-fourths length of sensory setae, remaining setae of propodosoma one-half as long. Hysterosomal setae as long or slightly longer than sensory setae. In most specimen preparations hysterosomal setae appear wavy and expanding to slightly larger diameter at the terminal end. Ventral: Trochanteric setal formula: 1,0,1,0. Coxal setae claviform, formula: 3,1,4,2. Epimera easily discerned. Genital structures consisting of 2 pairs of internal knobs and 2 pairs of external setae. Paragenital setae, 2 pairs. Anal pore ventral; a-1 setae claviform, a-2 and a-3 setae long and filiform. A-2 lateral and off anal plate. Chelicerae three-fourths length of pedipalps, lightly punctate. Setae in association with cheliceral claw indistinguishable. Submental rostral setae about one-fourth distance from apex. Legs I same length as body. Tarsus I with two rhagidial solenidia subtended with a stellate seta. Tarsus II same as protonymph. No rhagidi-

forms on tibiae I or II. Ventral setae tarsus I, 5 pairs. Femora IV very enlarged with complete telo-basal division.

Tritonymph -- biology The remaining eight specimens of E. wisei were believed dead on 14 February. All were collected, cleared and found to be in the tritonymphal stage. The following season (1967-1968) attempts to rear tritonymphs through to adults were again tried. Field collections of tritonymphs were made on 29 December 1967, 11 January 1968 and 25 January 1968. In all cases the mites died. However, when specimens from the last group were examined on 18 February 1968, i.e., those placed in culture 25 January it was found that six of the original 32 tritonymphs had molted to adult.

Tritonymph -- morphology Average length 315μ. Epirostral shoulders only slightly evident. Epivertex distinct. Division between pro- and hysterosoma slightly indicated. Internal vertical setae one-fourth length of sensory setae, remaining dorsal setae as long or longer than sensory setae. Hysterosomal setae expanded to slightly enlarged diameter at terminal end. Ventral: Trochanteric setal formula: 1,1,1,1. Coxal setal formula: 3,1,4,2. Genitalia with 2 pairs of internal knobs and 3 pairs of external genital setae. Paragenital setae, 4 pairs. Anal pore and setation same as deutonymph. Appendages: Chelicerae and submental rostrum same as deutonymph. Seta proximal to cheliceral claw sometimes seen if oriented correctly. Legs II one-third as long as body. Legs I one-and-one-half times as long as the body. Tarsi I and II each with two rhagi-

diforms subtended with stellate and nude setae respectively. No evidence of rhagidial solenidia on tibiae. Tarsus I with 6 ventral pairs of setae, the sixth and apical pair usually hidden by the next closest pair. Tarsi II, III and IV same as deutonymph. Femora III divided, leg segments adorned with one or more long filiform setae similar to but not as long as those of hysterosoma. Telofemur IV enlarged with two long filiform setae. Basifemur small with one long filiform seta.

Biology summary -- E. wisei Though E. wisei was effectively retained through several molts in vitro, little is known concerning its feeding habits. Protonymphs were the only stages observed to feed. It is apparent that the mites were subsisting on plant life present in the cultures; however, the food supply was inadequate as is evidenced by the rapid die off of the original in vitro adults, the later deutonymphs and the tritonymphs of the 1967-1968 season. The diatom present in the culture was identified as Navicula muticopsis. It is a heavy xanthin producer and is suspected of being the contributing factor in the generally darker and more reddish appearance of E. wisei specimens in vitro. All stages of E. wisei taken from their natural habitat had ivory- to orange-colored legs and the dorsal longitudinal stripe of the hysterosoma was a light yellow color. In the laboratory cultures it was a deep brownish-red. Navicula sp. is seldom found in the native microhabitat of E. wisei. It is believed that the natural food for these mites is an alga peculiar to its microhabitat. However, none has

been isolated for demonstration.

A schedule of days and dates in culture for each stage appears as follows:

Stage	Date placed in culture or molting observed	Days
Tritonymph	27, 28 November 1966	
		5-6
Adult	2 December 1966	
		Dead
Adult (Field collected)	2 December 1966	
		17
Egg	19 December 1966	
		14
Larva	2 January to 12 January 1967	
		10-18
Protonymph	12 January 1967	
		14
Deutonymph	26 January to 10 February 1967	
		14-28
Tritonymph	14 February 1967	
		Dead
Tritonymph	29 December 1967	
		Dead
Tritonymph	11 January 1968	
		Dead

Tritonymph	25 January 1968	
		Dead (?25)
Adult	18 February 1968	

Morphology summary -- E. wisei Dorsal chaetotaxy is complete in all stages. The division between the pro- and hysterosoma can be seen in all immature stages as well as in the adult. Epirostral shoulders are evident in all immatures, however, they cannot be seen in the adult.

Body size averages in microns are compared as follows:

Larva	185
Protonymph	210
Deutonymph	230
Tritonymph	315
Adult	365

Trochanteric setal numbers:

	I	II	III	IV
Larva	0	0	0	-
Protonymph	0	0	1	0
Deutonymph	1	0	1	0
Tritonymph	1	1	1	1
Adult	1	1	1	1

The coxal setae, which are pronounced claviform in the early developmental stages, are less so in the tritonymph and adult stages.

The coxal setae numbers are compared as follows:

	I	II	III	IV
Larva	2	1	2	-
Protonymph	3	1	2	0
Deutonymph	3	1	4	2
Tritonymph	3	1	4	2
Adult	3	1	4	3

As in S. belli the most important morphological characters for differentiation of immatures are the presence or absence of external genital setae, internal genital knobs and paragenital setae. Additionally, the clavate coxal setae and the enlarged femora of the nymphs serve well for identification of E. wisei immatures. Genital structures are compared as follows:

	Pairs of setae on flaps	Pairs of paragenital setae	Pairs of internal genital knobs
Larva	-	0	0
Protonymph	1	0	1
Deutonymph	2	2	2
Tritonymph	3	4	2
Adult	6	5	2

Immature stages do not have internal papillae or internal genital setae. Additional reproductive structures such as the sperm sac in adult males are not present in immatures.

Rhagidial solenidia on tarsi I and II are compared as follows:

	Tarsus I	Tarsus II
Larva	1	1
Protonymph	1	1
Deutonymph	2	1
Tritonymph	2	2
Adult	2	2

No other solenidia are found on other leg segments. In the tritonymph and adult stages there is usually found one or more long filiform and slightly pilose seta on each leg segment.

Remarks -- morphology of E. wisei adult When Strandtmann described the ventral setae of adult E. wisei in Womersley and Strandtmann (1963) it was on the basis of the epimeral regions. Accordingly the epimeral setal counts were presented as: I,2; II,1; III,3; IV,2. It was at a later date that Strandtmann decided to delete the use of epimera and to describe the ventral setae on the bases of the coxal fields. This method includes the medial setae which had been mentioned separately by earlier workers.

It follows that the coxal setal formula for E. wisei as described and illustrated by Womersley and Strandtmann would be 3,2,5,3. The writer has examined more than 100 adult specimens from the type area and has never found the adult setal formula to be so indicated. The ventral view of the adult was one that had been found among Womersley's drawings by Strandtmann (Womersley and Strandtmann, 1963). It had been made before Womersley's death, subsequently to be

published in co-authorship with Strandtmann. It has been learned from communication with Strandtmann that the extra setae had been erroneously left on the drawing, i.e. one lateral and one medial of coxa III and one of trochanter III (Strandtmann, 1968). Additionally, the body length is somewhat longer than the writer has observed.

Fig. 19. Dorsal and ventral aspects of Eupodes wisei Womersley and Strandtmann, larva.

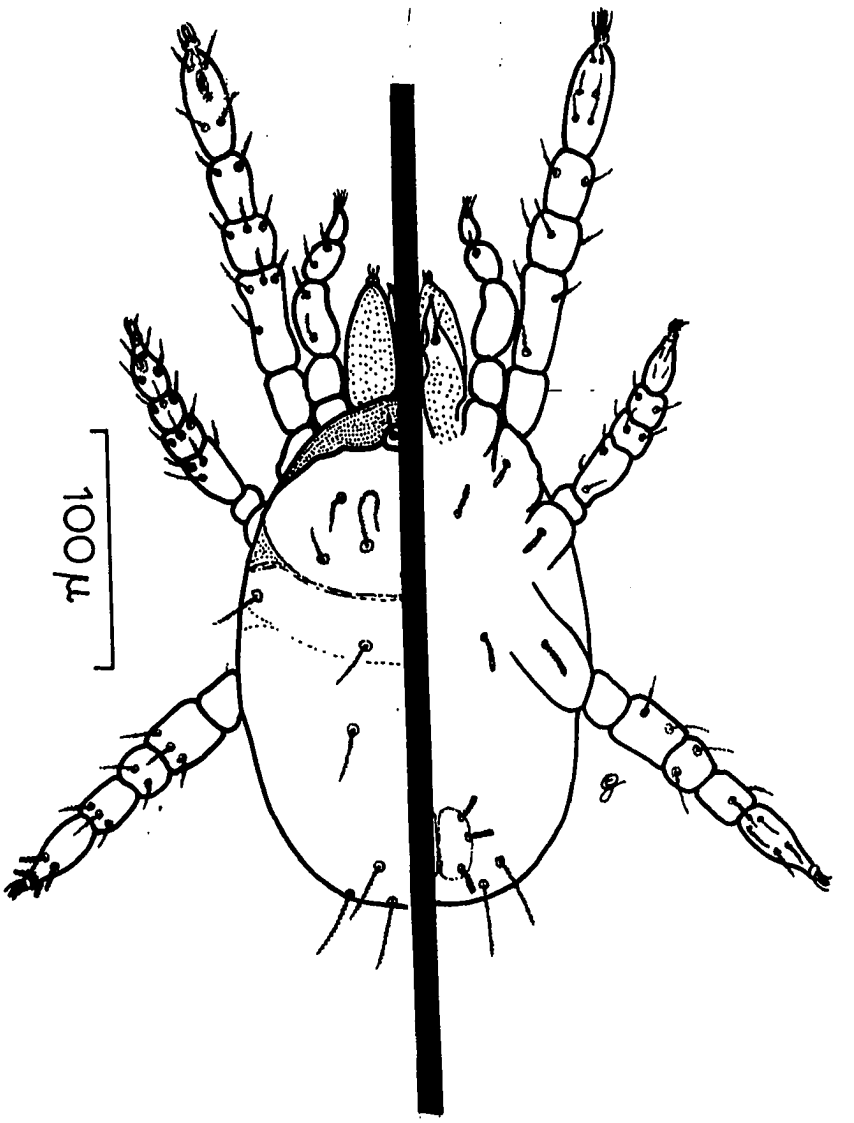
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Fig. 20. Dorsal and ventral aspects of Eupodes wisei Womersley and Strandtmann, protonymph.

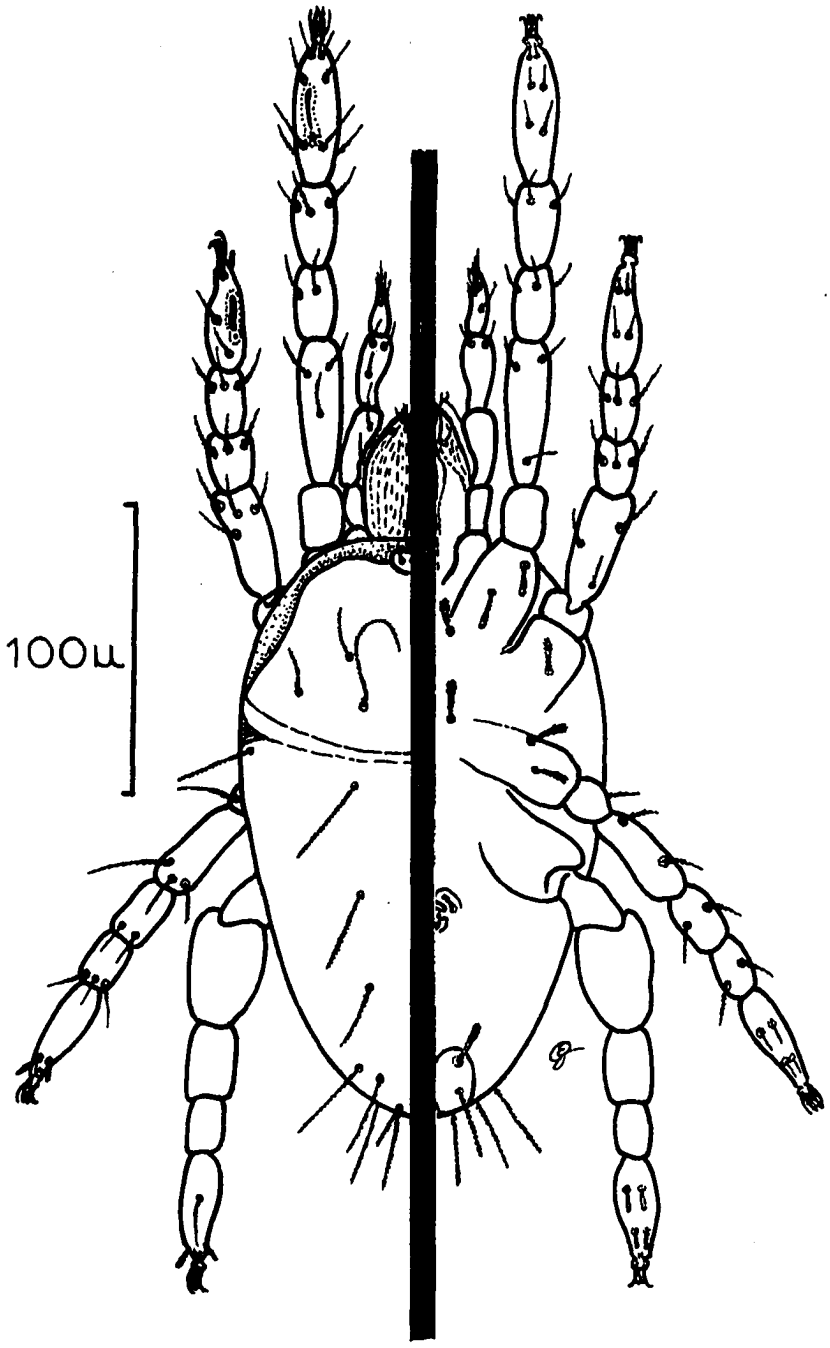
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Fig. 21. Dorsal and ventral aspects of Eupodes wisei Womersley and Strandtmann, deutonymph.

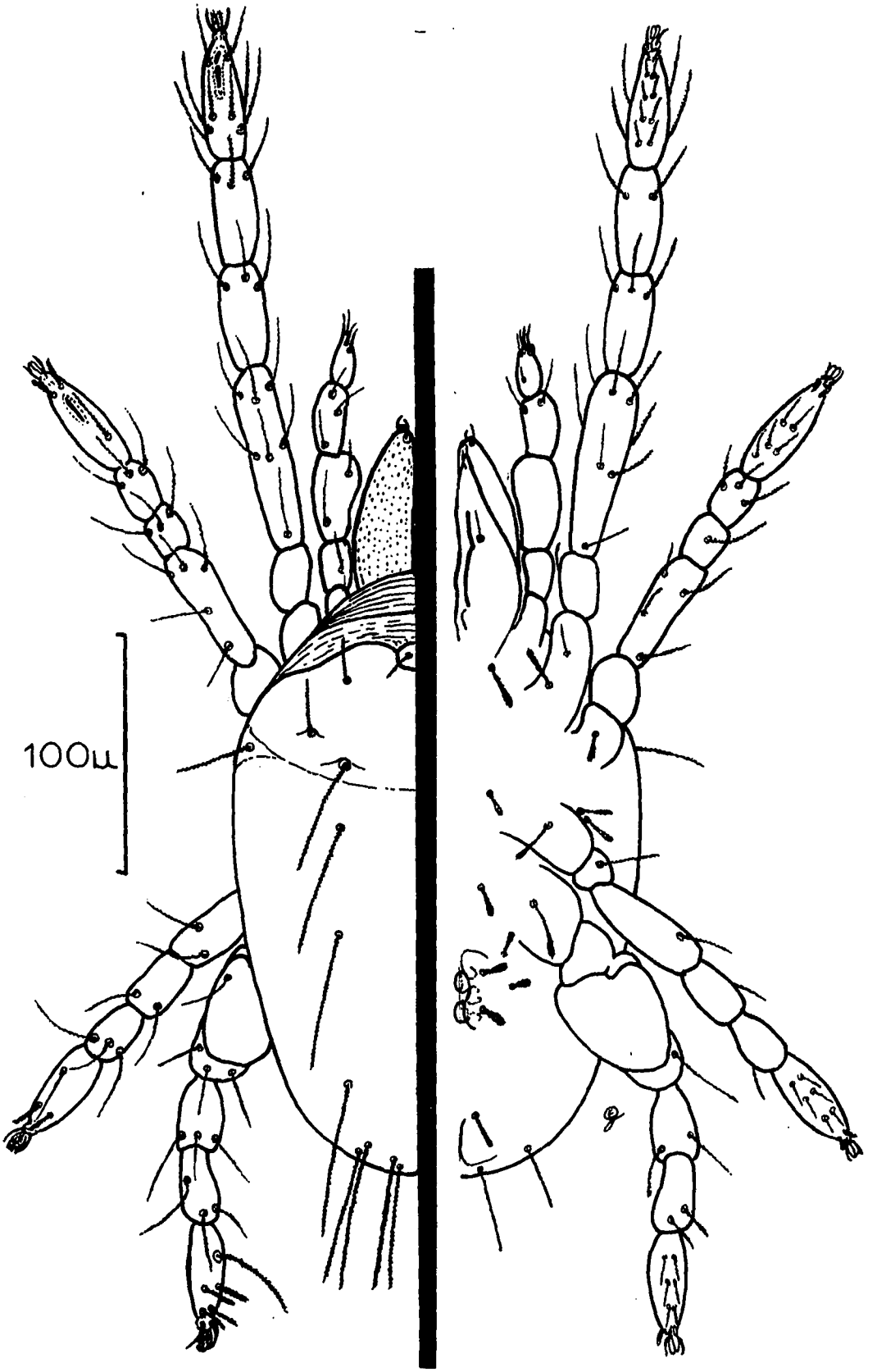

100µ

Fig. 22. Dorsal and ventral aspects of Eupodes wisei Womersley and Strandtmann, tritonymph.

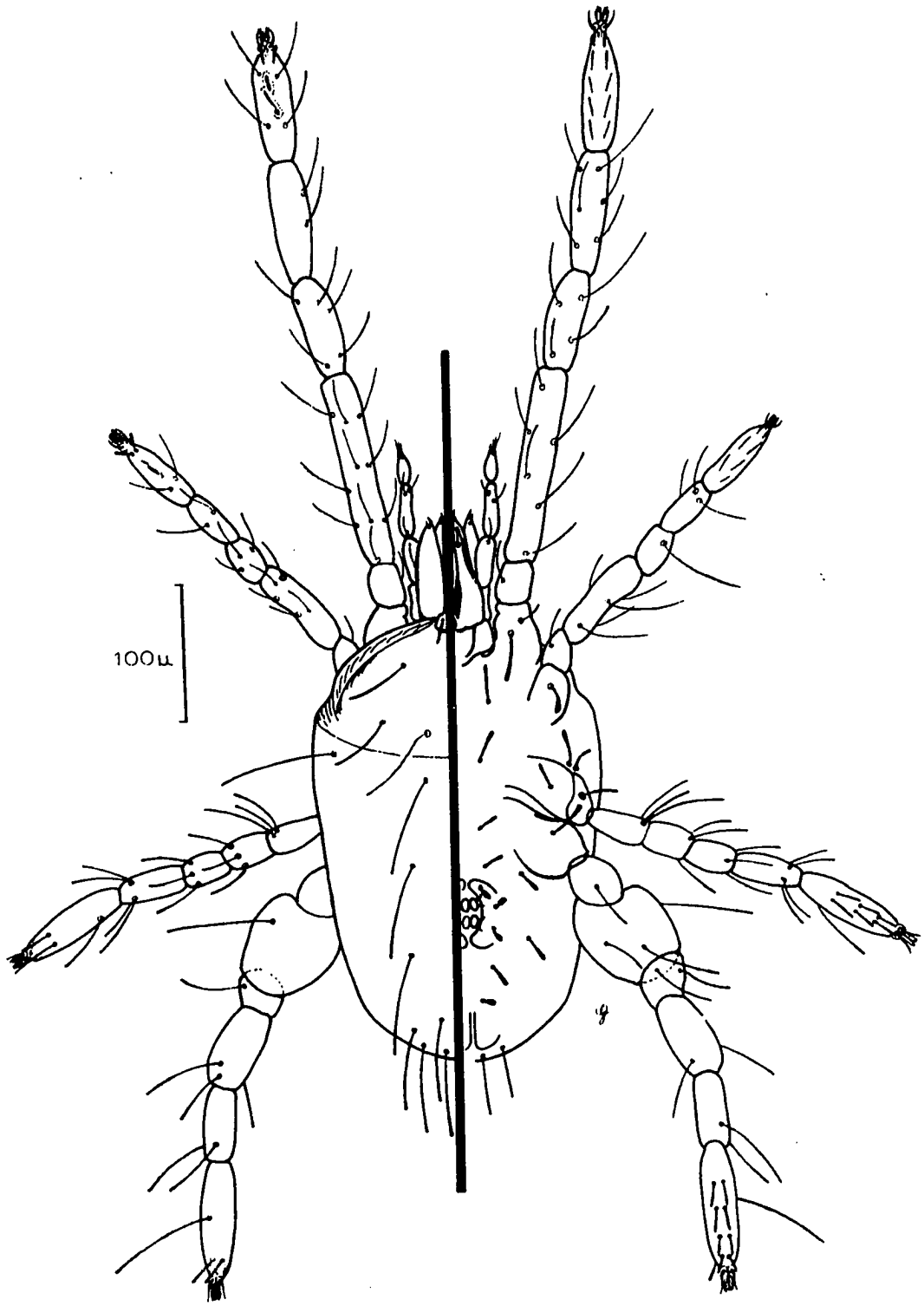
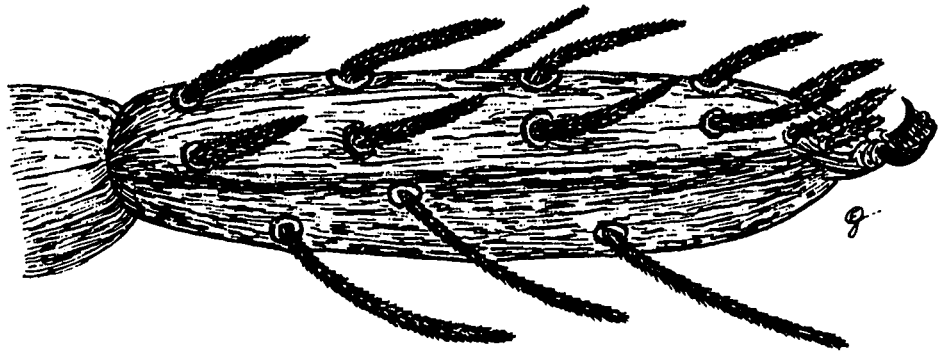
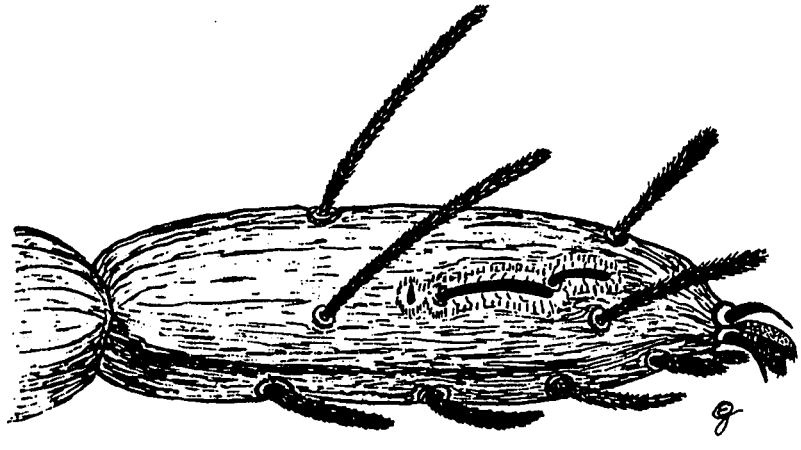

100µ

Fig. 23a. Tarsus I, ventral. Eupodes wisei Womersley and Strandtmann, tritonymph.

Fig. 23b. Tarsus II, dorsal. Eupodes wisei Womersley and Strandtmann, tritonymph.



50 μ



Protereunetes paulinae sp. n.

Figs. 24 through 35

Aspirator collections on 20 November 1966 taken N-NE of research site A were placed in Nesbitt's solution immediately. These contained mites of several species in various stages of development and when examined closely two specimens were found to be genus Protereunetes. No previous record of that genus had ever been made from North Victoria Land or Hallett Peninsula.

Attempts to collect additional specimens were fruitless until one month later when two mites of the same description were located in soil samples taken from approximately 200 feet below the crest of Hallett Peninsula.

The specimens were very delicate and when mounted in Turtox CMC-10 shriveled so badly they were rendered useless. The four mites, though unusable for further study, served an impetus for continued collecting. Consequently, a systematic search of the entire accessible cliff face was begun in which soil samples from every observable niche or variation of the microhabitat were to be taken to the laboratory for examination.

On 25 December 1966 numbers of adults of the new species were found in soil flotations that came from about 28 m SE of research site A at an elevation of approximately 15 m, Fig. 41. Vegetation of the microhabitat consisted of B. argentium clumps of which portions were dead and decaying and upon which were growing Nostoc sp., ?Oscillatoria and an abundance of the golden diatom, genus Navicula

(Fig. 42). P. crispa was found in small amounts throughout the area.

While all other prostigmatid mites found in the area are brightly colored, i.e., legs of red, orange or yellow and similar colored stripes on their striking black bodies, this species has a dark- to light-green body with a white longitudinal stripe on the hysterosoma. Occasionally the major color of the idiosoma is a deep maroon to orange. The body setae are white and easily seen with the dissection microscope. The legs are nearly always white or cream.

Additional soil and vegetation samples were placed in controlled humidity chambers and observed regularly. Adults as determined from cleared specimens were collected from those samples and placed on mite-free vegetation from the area which had been previously prepared.

Larva -- biology On 20 January 1967 numbers of very slow moving larvae were observed. These, apparently of the new species, were collected in excess of 50 and placed in isolation. Their colors were uniformly light-green to ivory. No eggs were observed as apparently they are extremely small and blend with supporting soil and vegetation. When watched closely they appeared to be feeding on filaments of ?Oscillatoria sp., however, this was not definitely concluded.

Larva -- morphology Average body length 150μ. Dorsal: Epivertex prominent with 1 pair of short pilose setae and in some specimens appears to be positioned one-fourth length of propodosoma

above and posterior to bases of chelicerae. Propodosoma soft in region bounded by sensory, external and scapular setae; lightly punctate outside that area. Sensory setae two to three times longer than remaining dorsal setae. Division between pro- and hysterosoma distinct. One sacral seta absent, one ventral seta present. Ventral: Rostral setae, internals basal, externals absent. Coxal setal formula: 2,1,2. Trochanteric setae, none. Genital structures, none. Paragenital setae, none. Anal pore terminal with 3 pairs of setae. Appendages: Chelicerae well developed and lightly punctate. Pedipalps two-thirds length legs I and nude ventrally except for apex. Legs dorsal: Tarsi I and II with one rhagidiform subtended by short pilose seta. Tibiae I and II with small rhagidiform anterior-dorsal and apical. Tibia I with very delicate globose solenidion medial. Tibia II with area where delicate globose solenidion may or may not be. Tibia III with delicate nude solenidion basal. Genu I with medial nude solenidion. Genu II with area where solenidion may or may not be. Legs ventral: Tarsi I with 3 pairs setae. Tarsi II with 1 pair and one seta of a second pair. Tarsi III with 2 pairs of setae.

Protonymph -- biology Thirteen days after the appearance of the first larva, 1 February 1967, several of the mites appeared more active, and, when closely observed, were found to have a fourth pair of legs. When watched closely with subdued blue light the mites were observed to feed on the filamentous ?Oscillatoria sp. Three were collected and prepared for study.

Protonymph -- morphology Average length 180μ. Dorsum same as larva except for slight sclerotization of propodosoma in region of sensory setae and complete dorsal chaetotaxy. Ventral: Coxal setal formula: 3,1,3,1. Trochanteric setal formula: 0,0,1,0. Internal and external rostral setae basal. Genital flaps indistinct. One pair of external genital setae and 1 pair of internal genital knobs. No paragenital setae. Anal pore terminal with 3 pairs of setae. Appendages: Chelicerae and pedipalps same as larva. Legs dorsal: Same as larvae with legs IV present and nude except for 2 short pairs of setae and one long dorsal anterior seta on tarsi. Legs ventral: Tarsi I with 3 pairs setae, tarsi II and III with 2 pairs of setae, tarsi IV nude.

Deutonymph -- biology All cultures were active and were frequently observed to feed on ?Oscillatoria sp. On 12 February 1967 one was seen to be dragging a partly shed skin. It was taken for study. The rest of the mites subsequently molted. The cultures were more wet than those of S. belli or E. wisei. The decaying B. argentium was believed responsible for the wetness although it did not seem to affect the deutonymphs, as they remained active. The mites were difficult to keep in the culture dishes during the observations and several were lost. There were 13 mites remaining in five culture dishes at this point.

Deutonymph -- morphology Average length 200μ. Dorsal chaetotaxy complete. Sclerotization of propodosoma slightly in-

creased from protonymph condition. Hysterosoma appears broad (two-thirds of length) in the only culture specimen examined. Field-collected mites with the same setation and genital structures did not indicate equivalent comparative width. Such a condition is believed due to newly molted state and the mounting medium. Division between pro- and hysterosoma evident. Ventral: Coxal setal formula: 3,1,4, 2(3). Trochanteric setal formula: 0,0,1,0. Rostral setae basal. Genital flaps distinct with 2 pairs external genital setae and 2 pairs of internal genital knobs. Two pairs paragenital setae. Anal pore terminal with 3 pairs of setae. Appendages: Chelicerae and pedipalps same as protonymph. Legs, dorsal: Tarsus I with one rhagidiform subtended with a stellate seta. Tarsus II with two rhagidiforms subtended with a nude seta. Remaining dorsal solenidia of legs same as protonymph. Legs, ventral: Tarsus I with 3 pairs of setae, remaining tarsi with 2 pairs.

Tritonymph -- biology Unlike S. belli, P. paulinae mites reached more mature stages of development later in the season. Though the mites in culture were active and feeding well they were still in the deutonymph stage by mid-February. When making a final observation on 22 February 1967 before closing the station, two recumbent mites were found and taken for clearing and mounting. When closely examined they were seen to be molting to tritonymphs. The remainder of the cultures subsequently died enroute to Iowa State.

The following season, 1967-1968, the mites were again placed in culture; however, contamination with mold was so extreme it caused

the entire loss of all P. paulinae cultures.

Tritonymph -- morphology Average length 250μ. Epirostral shoulder region pronounced though lightly sclerotized. Sclerotization in region of sensory setae increased. Division between pro- and hysterosoma evident. Hysterosoma broad (three-fourths of length), however, does not appear as ballooned as deutonymph. Field-collected mites with same morphology had hysterosomal width of same general appearance. Ventral: Coxal setal formula: 3,1,4,3. Trochanteric setal formula: 0,1,1,0. Genital flaps distinct with 3 pairs external genital setae and 2 pairs of internal genital knobs. Three pairs paragenital setae. Anal pore terminal with 3 pairs of paragenital setae. Appendages: Chelicerae and pedipalps same as proto- and deutonymphs. Legs, dorsal: Tarsus I with two rhagidiforms subtended with stellate solenidion. Tarsus II with three rhagidiforms subtended with a nude seta. Remaining dorsal solenidia of legs same as proto- and deutonymphs. Femur III with slight indication of division. Femur IV divided. Both femora III and IV and genu IV with posterior granulations. Legs, ventral: Tarsus I with 4 pairs, remaining tarsi with 2 pairs of setae.

Adult -- morphology Average size 280μ. The fine dorsal sensory setae of the propodosoma are about one-third again as long as the external verticals, two-thirds again as long as the internal verticals and about twice as long as the scapulars and internal and external humeral setae. The scapulars and humerals are essentially the same length as the remaining dorsal setae of the hysterosoma.

Division between pro- and hysterosoma evident. Body more elongate than deuto- or tritonymph stages. Ventral: Coxal setae formula: 3,1,4,3. Trochanteric setal formula: 1,1,1,0. Genitalia in both sexes similar. Genital flaps elongate and easily distinguished, each with six external genital setae. The anterior-most pair, slightly longer than the remaining 6 pairs of internal genital setae, can be seen medial or posterior to 2 pairs of genital knobs. A pouchlike structure can be seen in some specimens, which is considered a sperm sac as it has never been observed when eggs are present in them. Paragenital setae are four. The anal pore is ventral to a terminal position. Three pairs of para-anal setae with a-l much shorter than the other two. Appendages: Chelicerae well developed with terminal claws. Internal and external rostral setae basal. Pedipalps one-half as long as legs I, terminal segment with three or four setae apical, next to terminal segment with one posterior-ventral seta apically. Remaining setae of pedipalps nude ventrally. Legs, dorsal: Solenidia numbers same as tritonymph. Femora III and IV divided with posterior granulations that extend to include trochanter of each. Legs, ventral: Tarsi I with 6 pairs of setae. Remaining tarsi with 3 pairs. Numbers of setae for each leg segment are recorded as follows:

	Tar	Tib	Gen	Fem	Troc
I	20	6	6	11	1
II	11	5	4	8	1
III	11	4	3	7	1
IV	11	5	3	6	0

Biology summary -- P. paulinae All attempts to rear P. paulinae to the second filial generation in both 1966-1967 and 1967-1968 seasons were failures. The mites were retained in vitro from adult through egg, larva, protonymph, deutonymph to tritonymph but none were reared to adult. Larvae were observed to move very slowly in the culture dishes and were believed to feed on the filamentous ?Oscillatoria growing on the wet decaying surface of B. argentium. Protonymphs and deutonymphs were seen to actively feed on the same alga.

A schedule of days and dates in culture for each stage appears as follows:

Stage	Date placed in culture or molting observed	Days
Adults	25 December 1966	
(Eggs)	(?)	
		26
Larva	20 January 1967	
		13
Protonymph	1 February 1967	
		11
Deutonymph	12 February 1967	
		10
Tritonymph	22 February 1967	
		?Dead

Since tritonymphs were not found in culture or in vivo until late February, it is suspected that this species spends the winter

months in that stage.

Morphology summary -- P. paulinae Body size of the developmental stages are compared as follows (averages):

Larva	150μ
Protonymph	180μ
Deutonymph	200μ
Tritonymph	250μ
Adult	280μ

One sacral seta is ventral and one absent in the larval stage. All succeeding stages have complete chaetotaxy. The epirostral region anterior and ventral to the epivertex is rounded and easily seen in the larva, protonymph and deutonymph. The propodosomal shoulders are pronounced and appear to encroach upon the epirostrum and epivertex. Ventral: The chelicerae are well developed and very lightly sclerotized. A lightly chitinized ?esophageal tube can be seen at the bases of the submental rostrum and chelicerae in all nymphal stages. The structure is clearly visible, sometimes looped and extends to coxa III area.

Coxal setae numbers are compared as follows:

	I	II	III	IV
Larva	2	1	2	-
Protonymph	3	1	3	1
Deutonymph	3	1	4	2(3)
Tritonymph	3	1	4	3
Adult	3	1	4	3

Trochanter setal numbers are compared similarly:

	I	II	III	IV
Larva	0	0	0	-
Protonymph	0	0	1	0
Deutonymph	0	0	1	0
Tritonymph	0	1	1	0
Adult	1	1	1	0

As in S. belli and E. wisei the most important morphological characters for differentiation of immatures are the presence or absence of external genital setae, internal genital knobs and paragenital setae. Additionally, the rostral setae (larvae, 1 pair; all nymphs and adults, 2 pairs) are clearly basal in all stages of P. paulinae.

Genital structures increase in complexity with each molt. They are compared as follows:

	Pairs of setae on genital flaps	Pairs of paragenital setae	Pairs of internal genital knobs
Larva	-	0	0
Protonymph	1	0	1
Deutonymph	2	2	2
Tritonymph	3	3	2
Adult	6	4	2

Immatures do not have internal genital setae while adults have 6 pairs which are usually medial or posterior to the genital knobs.

The male sperm sac as seen in adults has never been observed in immatures.

Rhagidiforms are compared as follows:

	Tarsus I	Tarsus II
Larva	1	1
Protonymph	1	1
Deutonymph	1	2
Tritonymph	2	3
Adult	2	3

The anterior two rhagidial solenidia of adult tarsus II, are sometimes oriented in a parallel fashion forming a triangular pattern. The accompanying setae are short and pilose in the larval and protonymphal stages. The deutonymph, tritonymph and adult have stellate setae accompanying the rhagidiform(s) of tarsus I and a nude seta with the rhagidiforms of tarsus II.

Remarks -- P. paulinae This is the third species of genus Protereunetes to be reported from Antarctica. It differs from P. minutus and maudae Strandtmann (1967) in adult over-all body length, presence of solenidia on both genua I and II and absence of a seta on trochanter IV. Other differences are found in general body shape and leg setation.

The holotype will be deposited with the Bernice P. Bishop Museum. It has been collected at Hallett Station only by the writer. The name is derived from the writer's wife's name to fulfill a promise from early graduate school days.

Fig. 24a. Protereunetes paulinae sp. n. Larva, dorsal.

Fig. 24b. Protereunetes paulinae sp. m. Larva, ventral.

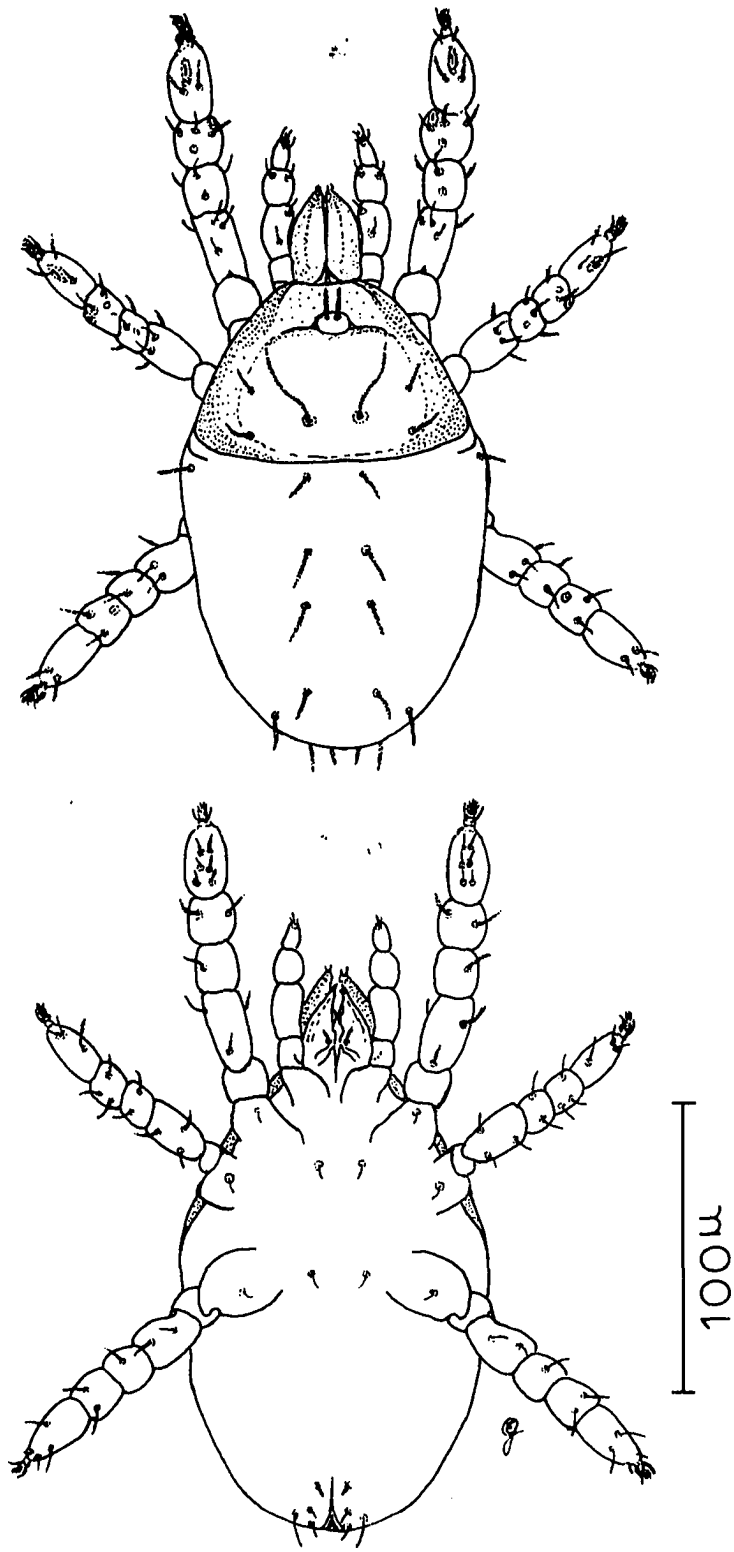

100μ

Fig. 25. Protereunetes paulinae sp. n. Dorsal, protonymph.

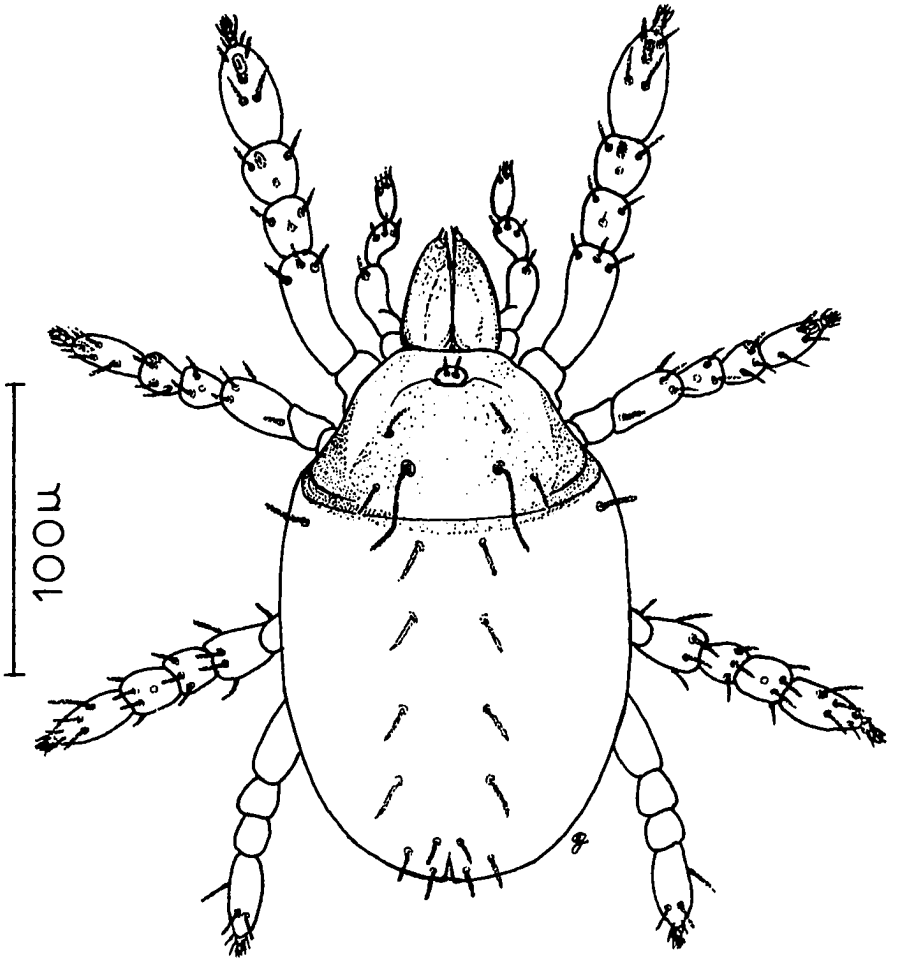

100μ

Fig. 26. *Protereunetes paulinae* sp. n. Ventral, protonymph.

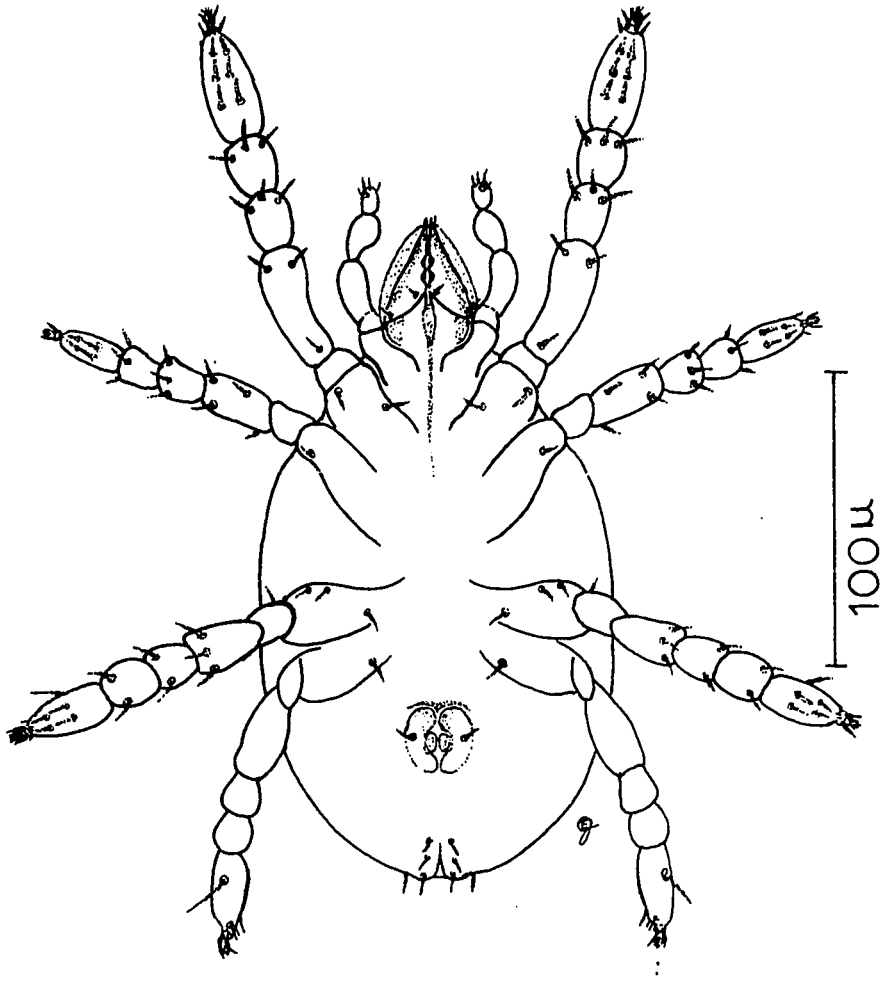

100μ

Fig. 27. Protereunetes paulinae sp. n. Dorsal, deutonymph.

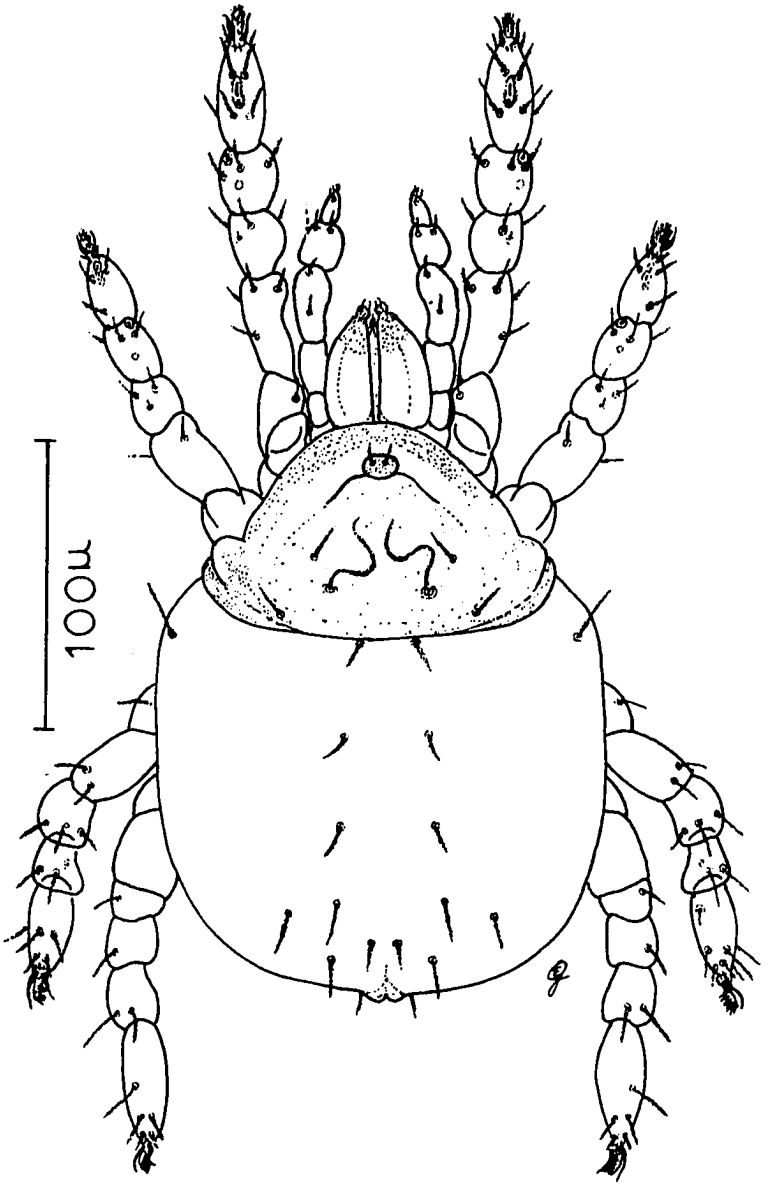

100μ

Fig. 23. Protereunetes paulinae sp. n. Ventral, deutonymph.

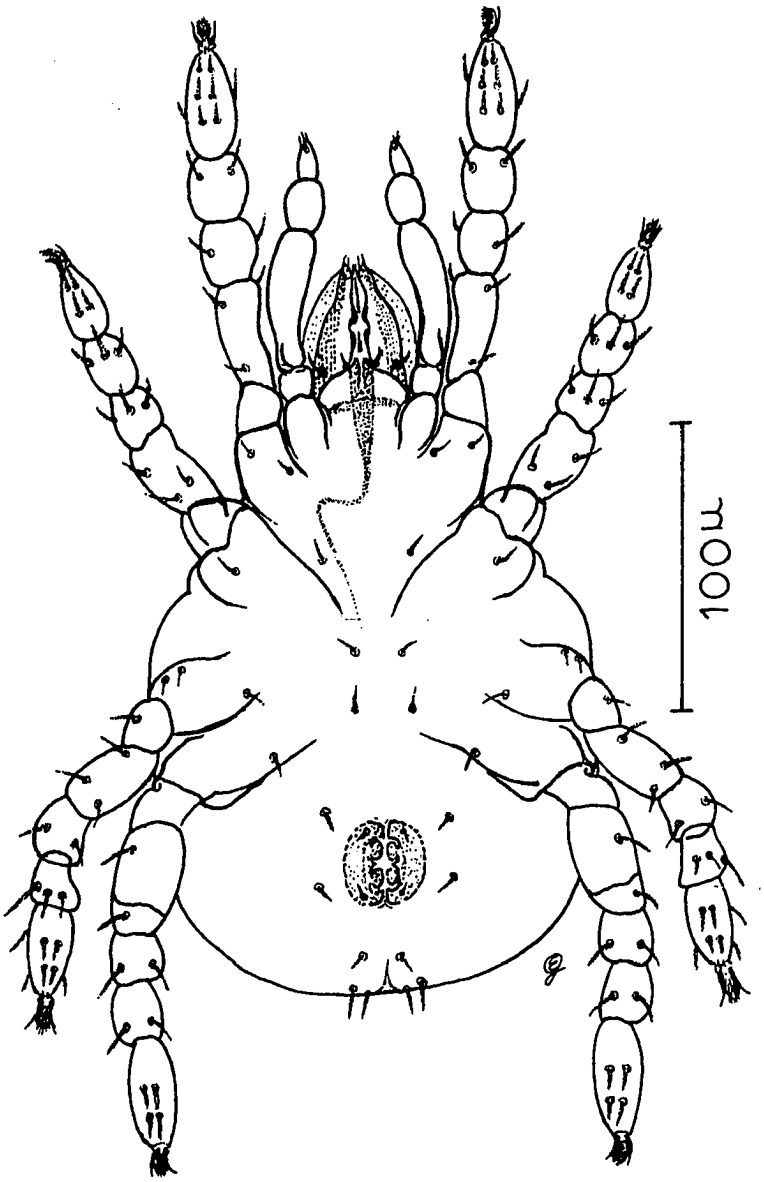

100μ

Fig. 29. Protereunetes paulinae sp. n. Dorsal, tritonymph.

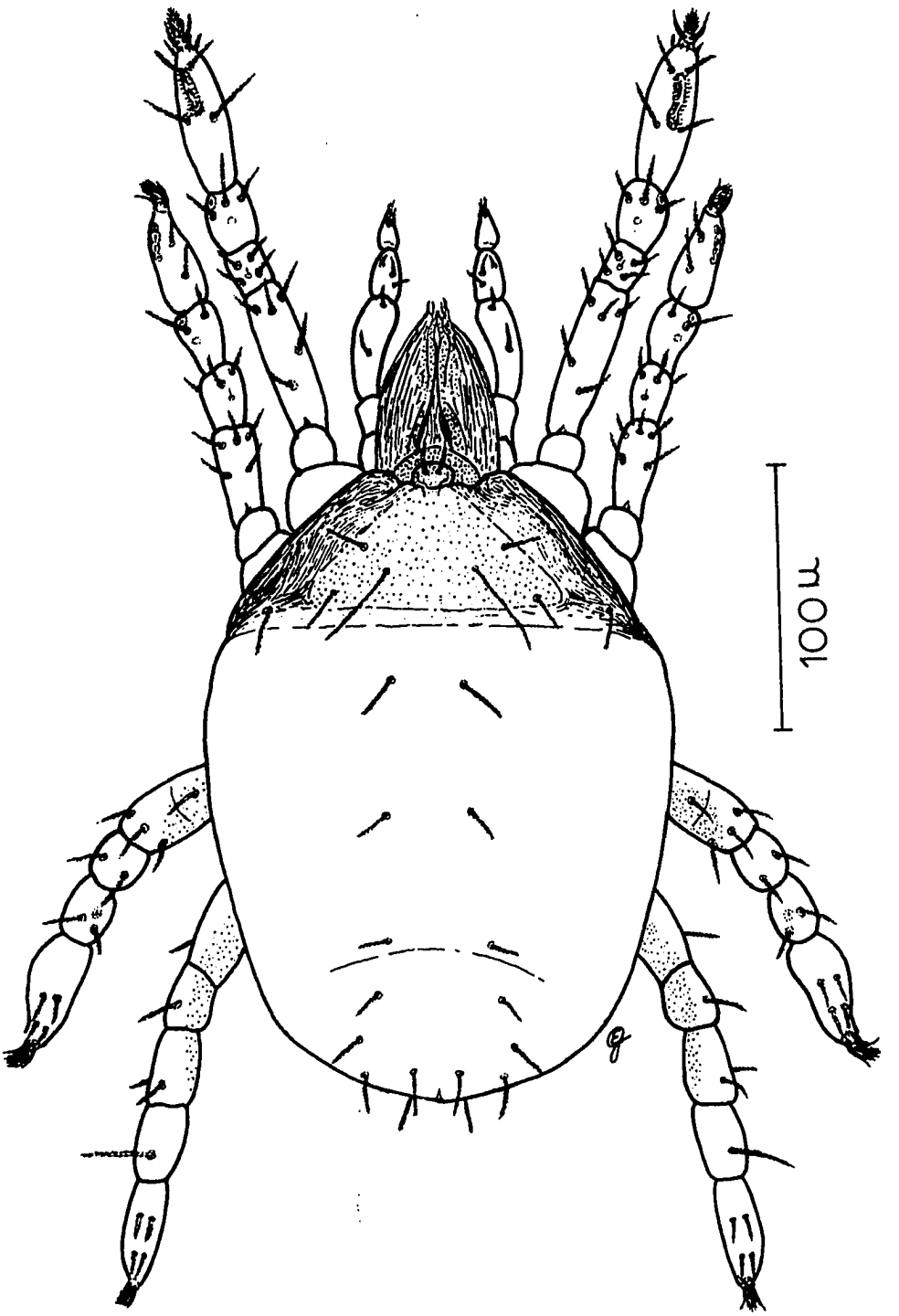

100 µ

Fig. 30. Protereunetes paulinae sp. n. Ventral, tritonymph.

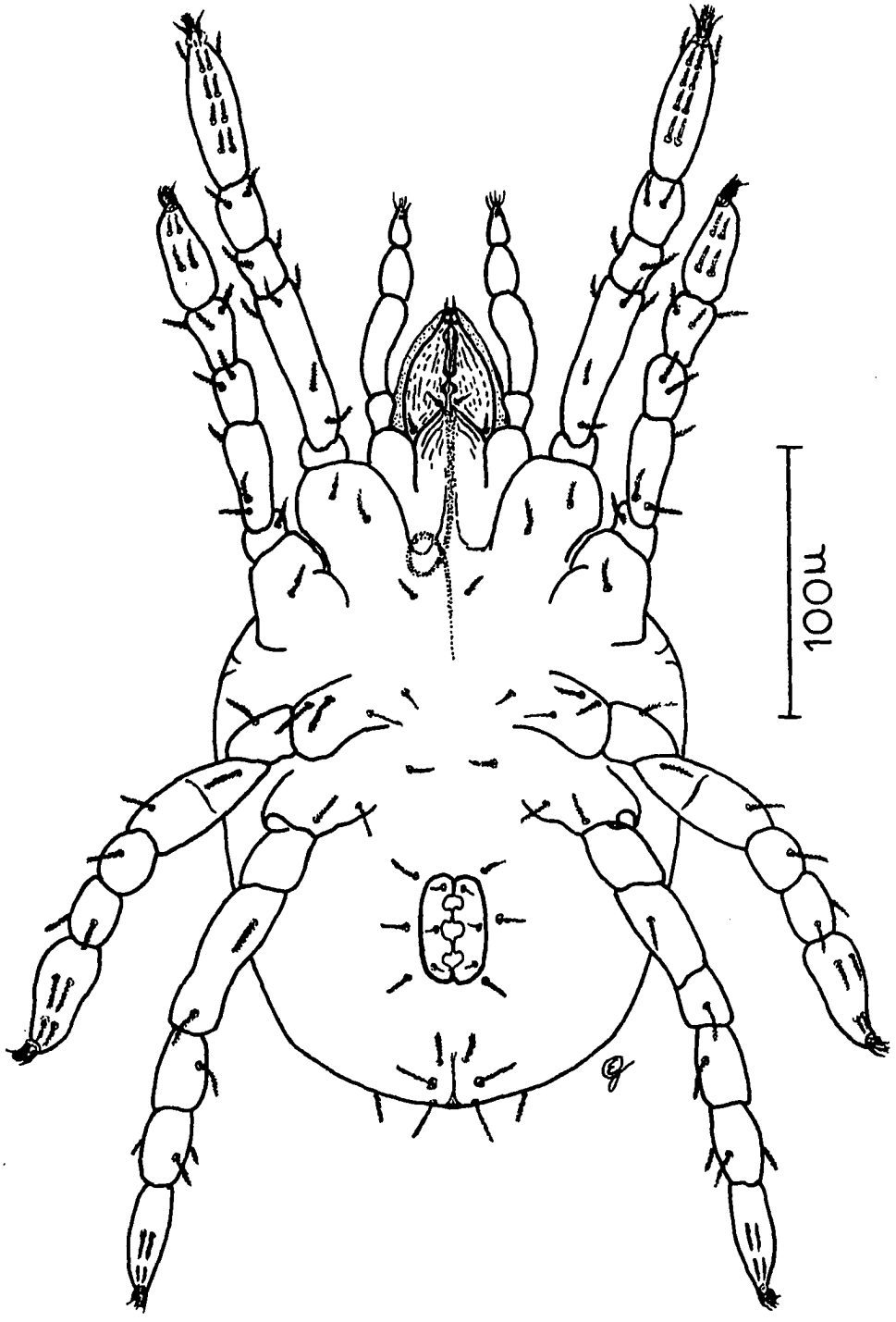

100µ

Fig. 31. Protereunetes paulinae sp. n. Dorsal, ♂.

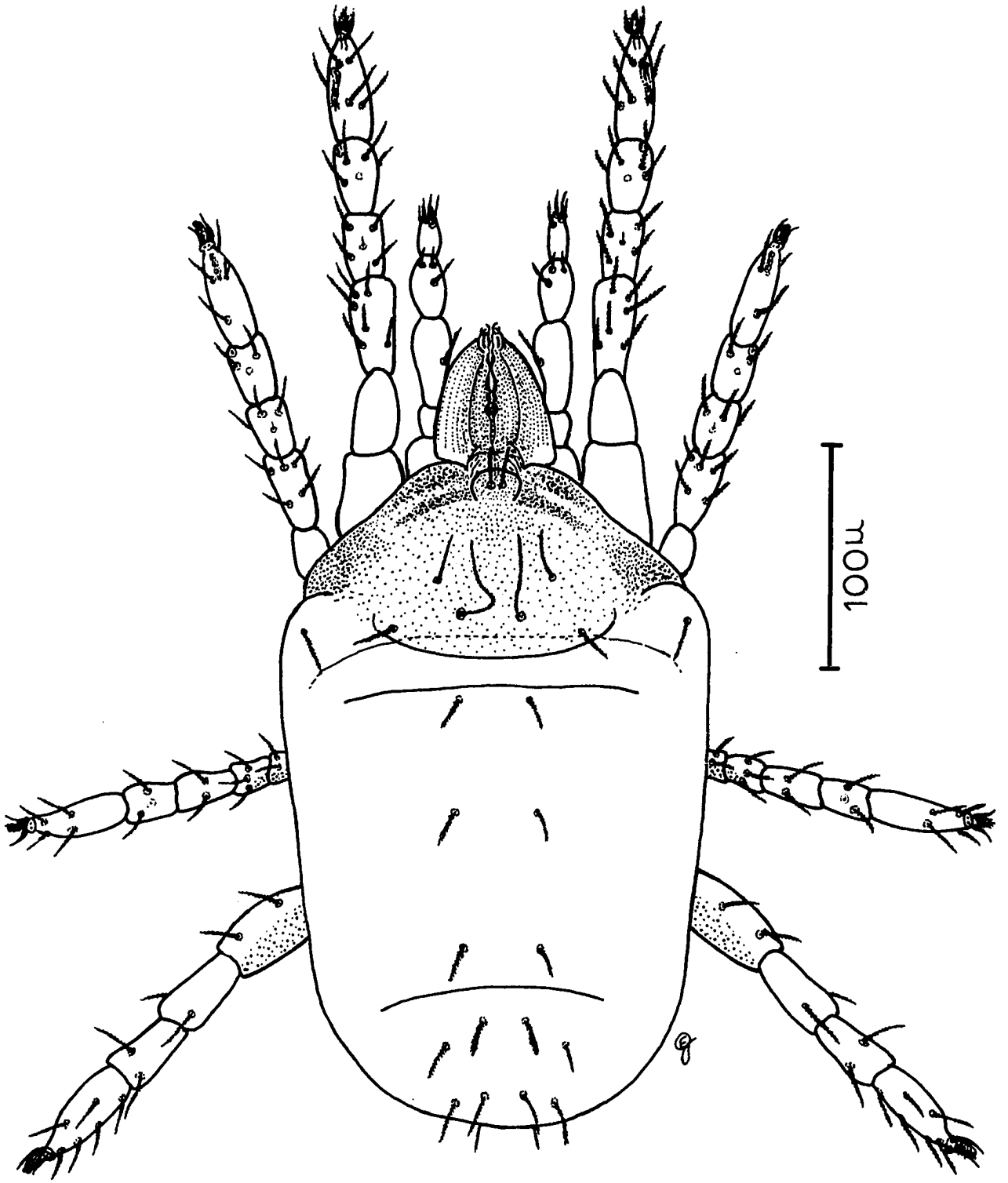

100µ

Fig. 32. Protereunetes paulinae sp. n. Ventral, ♀.

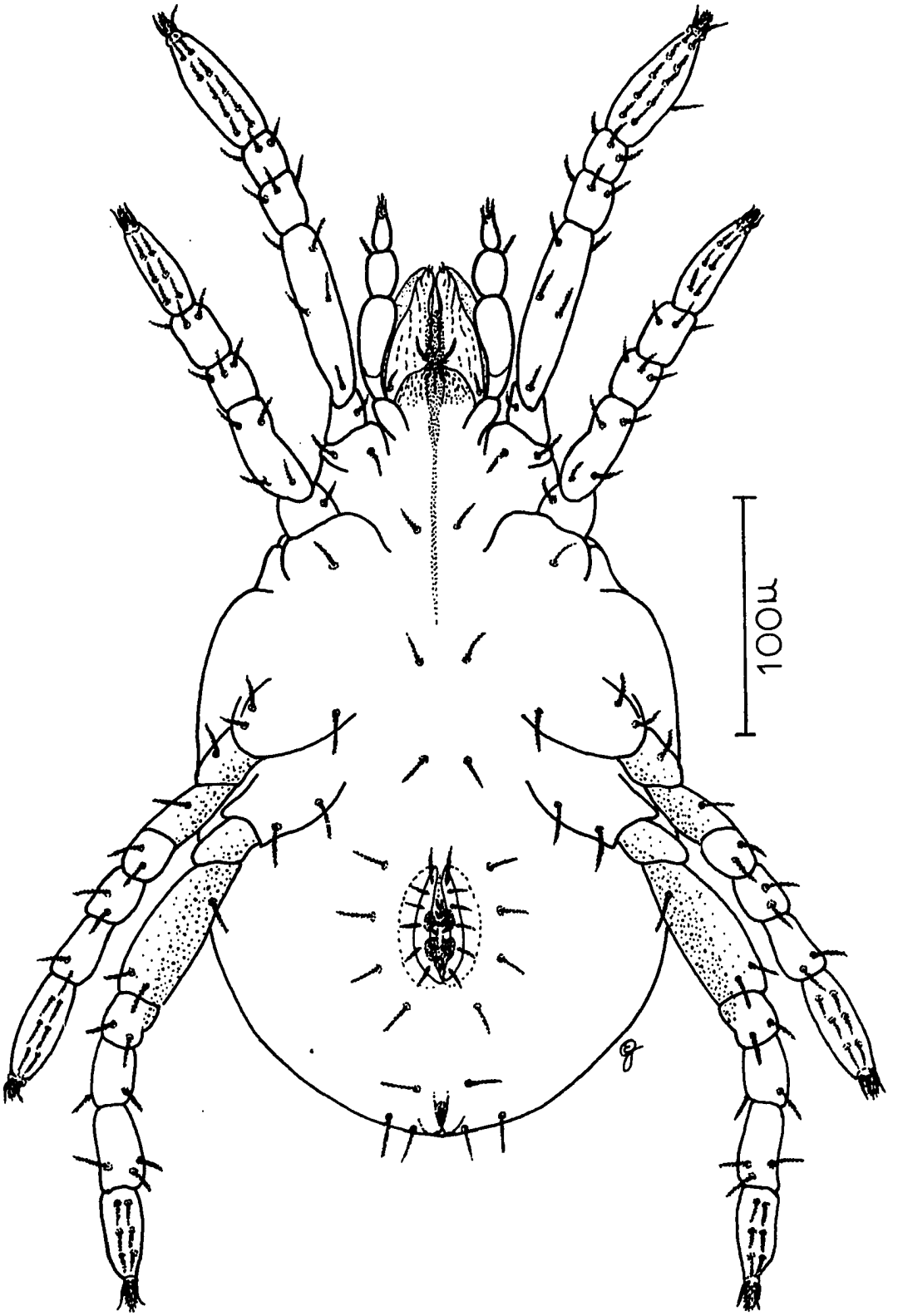

100µ

Fig. 33. Genital field, adult ♂, Protereunetes paulinae sp. n.

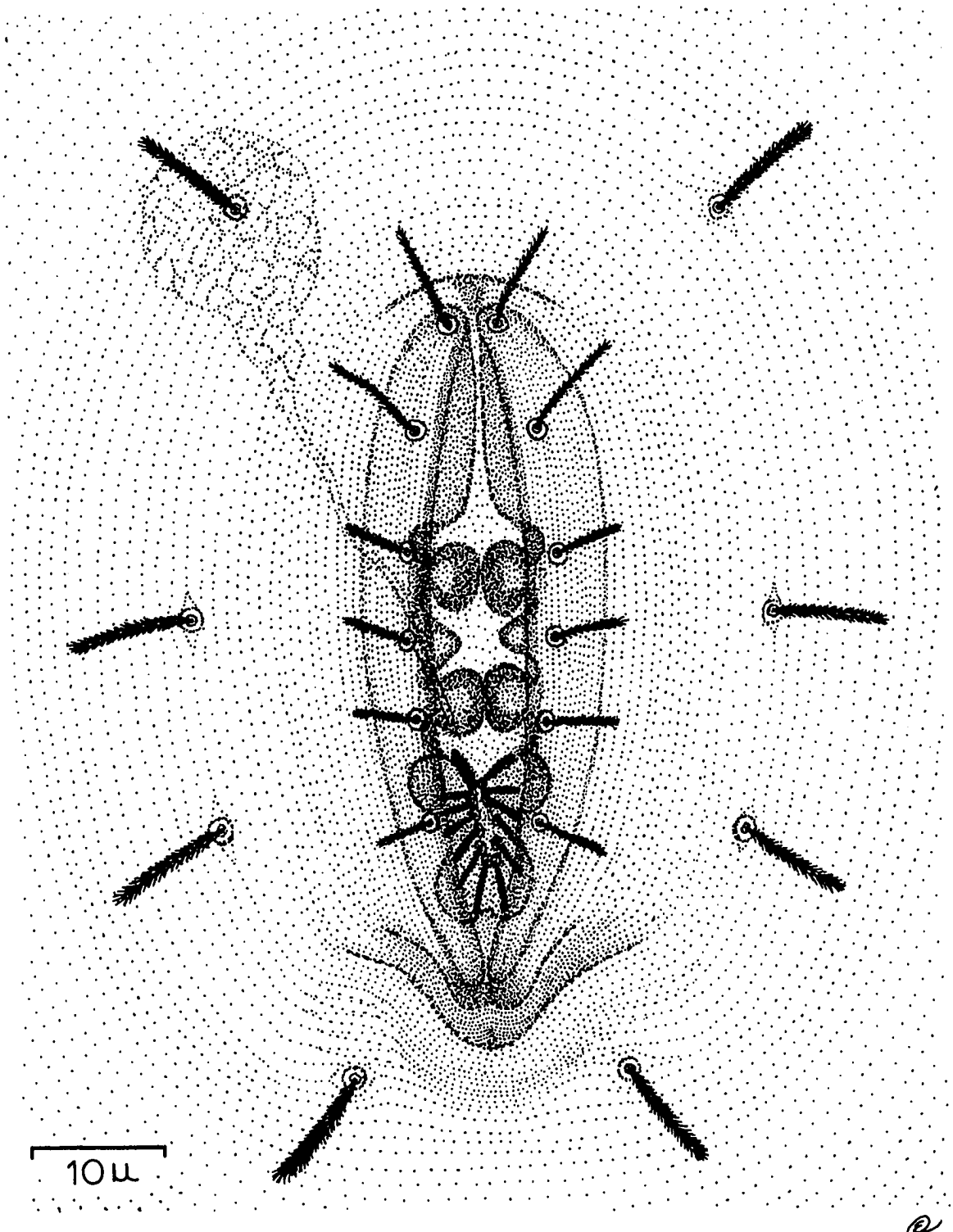
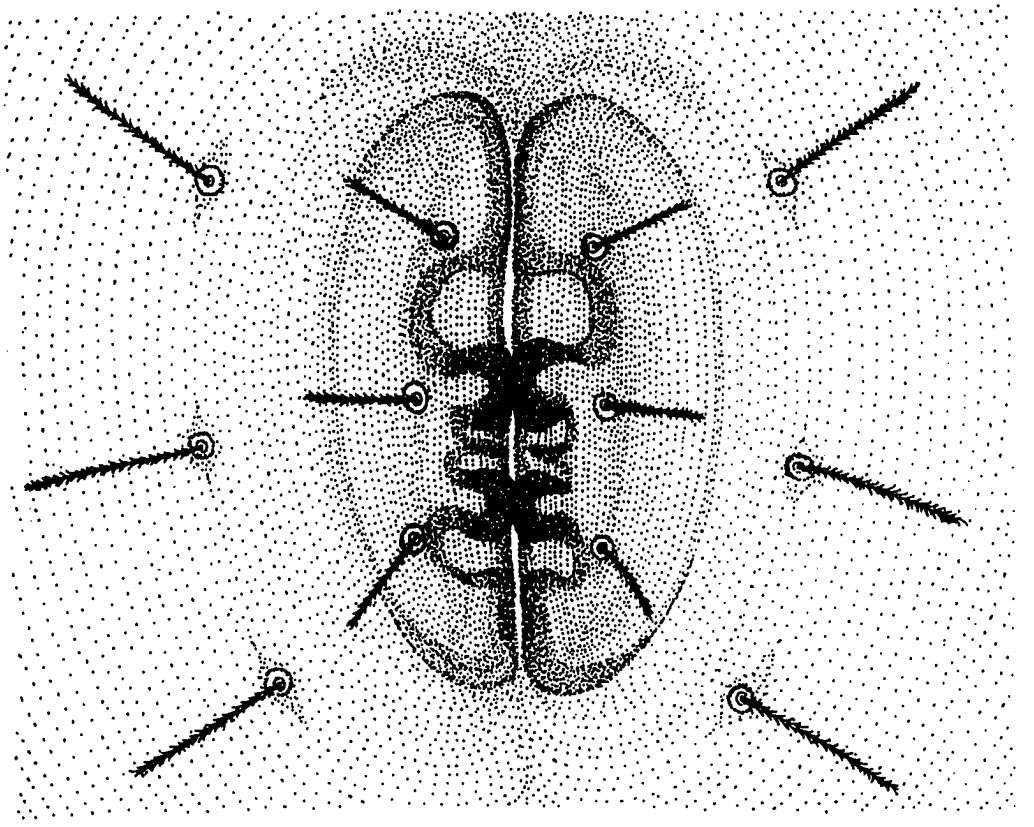
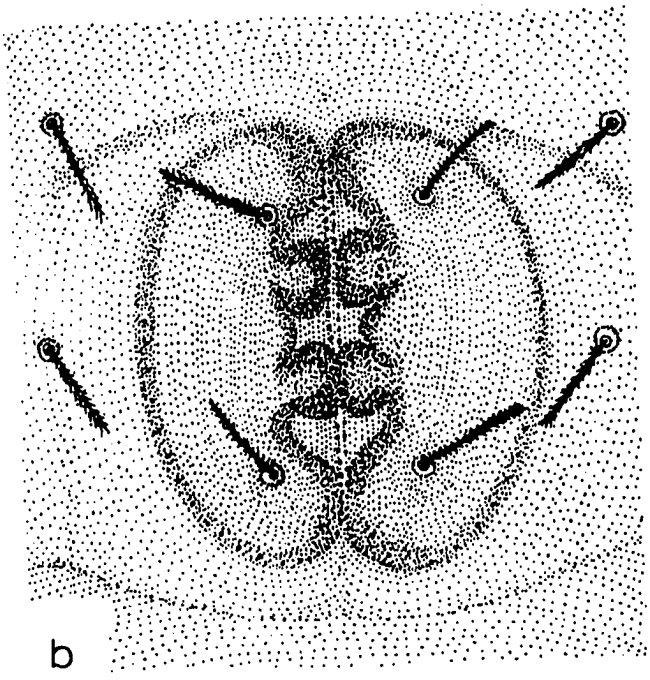

10 µ

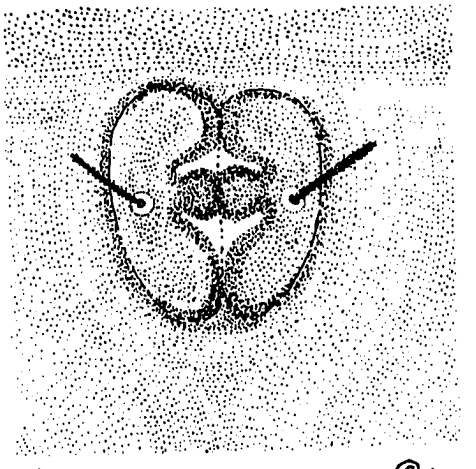
Fig. 34. Structural development genitalia, three nymphs of Protereunetes paulinae sp. n.; a. tritonymph; b. deutonymph; c. protonymph.



a



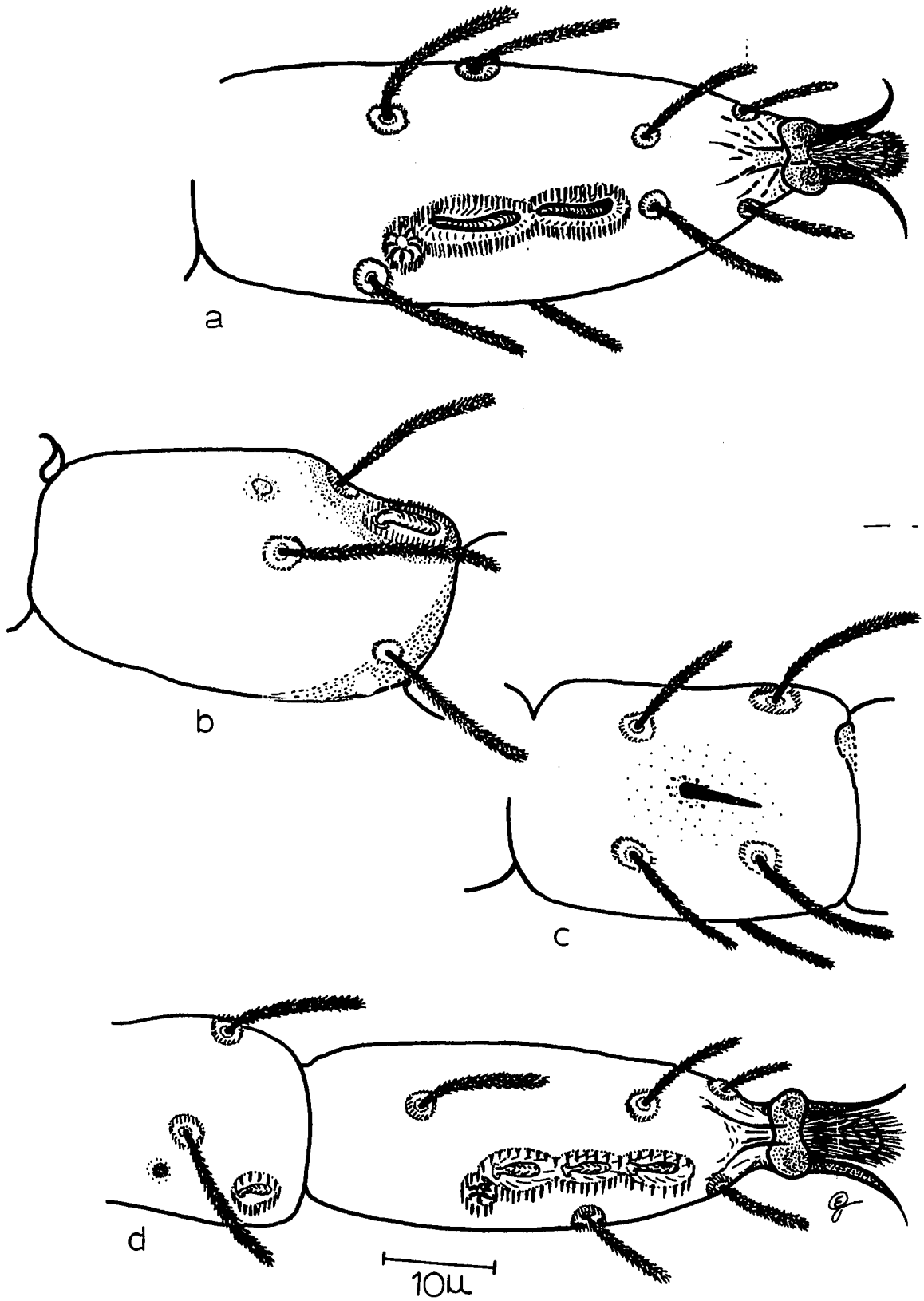
b



c

10μ

Fig. 35. Protereunetes paulinae sp. n.; a. tarsus I dorsal, b. tibia I dorsal, c. genu I dorsal, d. tarsus II and part of tibia II dorsal.


a
b
c
d
10u

Family Rhagidiidae Oudemans, 1922

Coccorhagidia gressitti Womersley and Strandtmann, 1963. Pacific Insects 5:467.

Figs. 36 through 42

C. gressitti have been found in all parts of the study area from two meters above the shoreline of Willett Cove to the top of Hallett Peninsula (ca. 1,000 feet). Its suggested predaceous feeding habits reported by Gressitt and Shoup (1967) were confirmed by Gless (1967).

Initial studies indicated S. belli tritonymphs as food for adults. When the larvae hatched in vitro during the initial study they later died without molting. Since vegetation in the culture was the only food offered, they probably starved to death.

It is impossible to differentiate between tritonymphs and adults with a dissection microscope, therefore, both were collected and placed in culture on 20, 21 and 22 November 1966. Twenty-five cultures with three and four mites in each were prepared as previously described. On 4 December 1966 several shed skins were found on the surface of the charcoal-plaster of Paris medium. Only one could be prepared in suitable condition for study. A portion of the exoskeleton from the genital region was the only part that could be examined. The external genital setae numbered three on one flap and four on the other; paragenital setae, five on one side and six on the other. The additional setae were confusing as they did not follow the pattern of the three previously described species.

On 22 December 1966 many pale-yellow eggs were found in the cultures. They averaged 165μ. As many of the adults as could be easily removed were transferred to other cultures. All were removed by the tenth day. Several attempts to transfer eggs to consolidating cultures were made but were discontinued as too harmful. Time and facilities did not permit photographing or drawing egg development.

Larvae -- biology On 14 January 1967 a number of larvae were found in the cultures. They were not disturbed as they moved very quickly and were hard to prevent from escaping. Neither molting nor shed skins were observed.

The immediate problem was food supply. Larvae of field-collected Stereotydeus sp. were offered and several were taken. Similar to adults they would simply grasp their prey, carry it a short distance and then proceed to chew at the lateral part of the opisthosoma.

Two were taken the next day for examination. It was determined that 18 remained in the cultures.

Larva -- morphology Average length 360μ. Dorsal: Epivertex pronounced with 1 pair of short pilose setae. Some evidence of epirostral shoulders between epivertex and bases of chelicerae. Dorsal chaetotaxy complete. Sensory setae globose and pubescent. Scapular, external humeral, external lumbar and sacral setae about twice length of remaining dorsal setae. Division between pro- and hysterosoma distinct. Ventral: Chelicerae well

developed, lightly punctate with strong apical claws. Pedipalps five-segmented, about one-half length of legs I with terminal segment spherical. Rostral setae are 2 pairs basal and 1 pair apical. Rostral margins smooth. Coxal setal formula: 2,1,2. Trochanteric setae, none. No genital structures. Anal setae 3 pairs. Legs: All femora undivided. Legs, dorsal: Tarsi I and II each with one cantilevered rhagidiform and without accompanying short setae. Legs, ventral: Tarsus I with 3 pairs setae, tarsus II with 2 1/2 pairs setae and tarsus III with 3 1/2 pairs setae. Legs IV absent. Tarsal claws and empodium delicate.

Protonymph -- biology Several more larvae of Stereotydeus sp. were taken by C. gressitti in culture, and three were found on 4 February 1967 to have molted to protonymphs. Most, however, remained in the larval stage. No attempt was made to separate them.

Protonymph -- morphology Average length 475μ. Dorsal: Epivertex pronounced but small, round and cone-shaped with two finely pilose setae. No epirostral shoulders showing. Dorsal chaetotaxy same as larva. Division between pro- and hysterosoma distinct. Ventral: Chelicerae well developed, lightly punctate with apical claws much reduced from larval condition. Pedipalps five-segmented slightly less than one-half length of legs I with terminal segment as broad as long. Rostral setae: Two pairs apical and 2 pairs basal. Rostral margins slightly dentate. Coxal setal formula: 3(2),1,3,0. Trochanteric setal formula: 0,1,1,0. Genital flaps

distinct with one seta on each. One pair of internal genital knobs and no paragenital setae. Anal setae same as larvae. Legs: Femora legs I and IV divided. Legs, dorsal: Tarsi I with single cantilevered rhagidiform and small accompanying stellate seta lateral to it. Tarsi II same as tarsi I except accompanying seta short and nude. Legs, ventral: Same as larva except legs IV present with setation of tarsi similar to that of tarsi I.

Deutonymph -- biology In the course of routine soil flotations on 7 February many immatures and eggs of Collembola were observed. Some of the eggs were offered to the protonymphs and larvae of C. gressitti. They fed on them readily and on 16 February 1967 the first deutonymph was collected. By 20 February 1967 all mites remaining had apparently molted to the deutonymph stage. There were six in two culture dishes.

Deutonymph -- morphology Average length 620μ. Dorsal: Epivertex same as protonymph. Epirostral shoulder region narrow and slightly protruding. Dorsal chaetotaxy complete and same as protonymph. Division between pro- and hysterosoma distinct. Ventral: Chelicerae well developed, lightly punctate with strong apical claws. Pedipalps five-segmented about one-third length of legs I with terminal segment spherical. Rostral setae and margins same as protonymph. Coxal setal formula: 3,1,4,3. Trochanteric setal formula: 1,1,2,1. Genital flaps distinct with 3 pairs of setae. Internal genital knobs 2 pairs. Legs: Femora I, III and IV divided. Legs,

dorsal: Tarsi I with two cantilevered rhagidiforms and accompanying stellate seta lying obliquely oriented. Tarsi II with single cantilevered rhagidiform and short, nude accompanying seta. Legs, ventral: Tarsal setae not in definite paired pattern and difficult to count.

Tritonymph -- biology The deutonymphs in culture did not survive the trip from Antarctica to Iowa State and all attempts to rear C. gressitti from early nymphal stages to adult during the following season, i.e., 1967-1968, failed due to extreme mold contamination. The only information collected was from cultures containing both tritonymphs and adults during the early part of the 1966-1967 season. As previously described, mites that had been held in culture from 20 November 1966 to 4 December 1966 molted, at which time only one shed skin was collected and examined.

Tritonymph -- morphology Morphology of field-collected mites with genital characteristics similar to those of other prostigmatid mites is presented here. Average size 700μ. Dorsal: Chaetotaxy complete. Epivertex small and round with 1 pair of pubescent setae. Division between pro- and hysterosoma distinct. Ventral: Chelicerae well developed with strong apical claws. Pedipalps five-segmented, slightly greater than one-fourth length of legs I and palptarsus spherical. Rostral setae 2 pairs apical and 2 pairs basal. Rostral margins dentate near the base. Pedipalps five-segmented with spherical apical segment, length about one-third of legs I. Coxal setal formula: 3,1,4,3. Trochanteric setal formula:

1,1,2,2(3). Genital flaps distinct with three, sometimes four or five setae on each. Paragenital setae 4, sometimes 5 or 6 pairs. Anal setae same as deutonymph. Legs: Femora same as deutonymph. Legs, dorsal: Tarsus I with three cantilevered rhagidiforms lying obliquely in a field with a stellate seta basal. Tarsus II with three cantilevered rhagidiforms, the anterior two tandem, the basal and medial one parallel with a short nude seta lateral to the basal rhagidiform. Legs, ventral: Tarsi with varying numbers of setae.

Biology summary -- C. gressitti Larvae of C. gressitti were observed to feed upon larvae of other mites. It was not learned that Collembola eggs and nymphs would be utilized until they were offered during the deutonymphal stage. It is probable that Collembola eggs are also the choice food for larvae and protonymphs. Tritonymphs and adults readily took tritonymphs of S. belli (Fig. 42). They would not, however, take Collembola in any stage of collembolan development.

A schedule of dates and days in culture is as follows:

Stage	Date placed in culture or molting observed	Days
Adult	24 December 1965	
		>1
Egg	25 December 1965	
		29
Larva	22 January 1966	
		53+-

Tritonymph and Adult	20 November 1966	
		14
Adult	4 December 1966	
		18->32
Egg	22 December 1966	
		24
Larva	14 January 1967	
		21
Protonymph	4 February 1967	
		12
Deutonymph	16 February 1967	

Nymphs were reported to have been collected in November by Gressitt and Shoup (1967). The writer collected tritonymphs in late October, and deutonymphs were observed to molt in the laboratory in late February. Consequently, it is assumed that the deutonymphs and tritonymphs represent the overwintering stages for C. gressitti.

Morphology summary -- C. gressitti Body sizes of the developmental stages are compared as follows (averages):

Larva	360μ
Protonymph	475μ
Deutonymph	620μ
Tritonymph	700μ
Adult	1,150μ

All stages have complete dorsal chaetotaxy. The chelicerae are very well developed with large apical claws. A lightly chitinized ?esophageal tube can be seen in the larval and protonymphal stages, however, not as readily in the later stages. The structure is clearly visible and extends to coxa III region.

Coxal setal numbers are compared as follows:

	I	II	III	IV
Larva	2	1	2	-
Protonymph	3(2)	1	3	0
Deutonymph	3	1	4	3
Tritonymph	3	1	4	3
Adult	3	1	4	3

Trochanteric setal numbers are compared similarly:

	I	II	III	IV
Larva	0	0	0	-
Protonymph	0	1	1	0
Deutonymph	1	1	2	1
Tritonymph	1	1	2	2(3)
Adult	1	1	2	3

Rhagidiforms are compared as follows:

	Tarsus I	Tarsus II
Larva	1	1
Protonymph	1	1
Deutonymph	2	1
Tritonymph	3	3
Adult	3	3

As with the other prostigmatid mites reported in this writing the genital structures are of major importance for differentiating the immatures. With the exception of the tritonymph the genital structures follow the same pattern. The structures are compared as follows:

	Pairs of setae on flaps	Pairs of paragenital setae	Pairs of internal genital knobs
Larva	-	-	-
Protonymph	1	0	1
Deutonymph	2	0	2
Tritonymph	3(4 or 5)	4(5 or 6)	2
Adult	7(8)	5	2

Immatures do not have internal papillae or genital setae while adults have 10 pairs of papillae with a single seta arising from each papilla.

Fig. 36. Coccorhagidia gressitti Womersley and Strandtmann. Larva, dorso-ventral aspect.

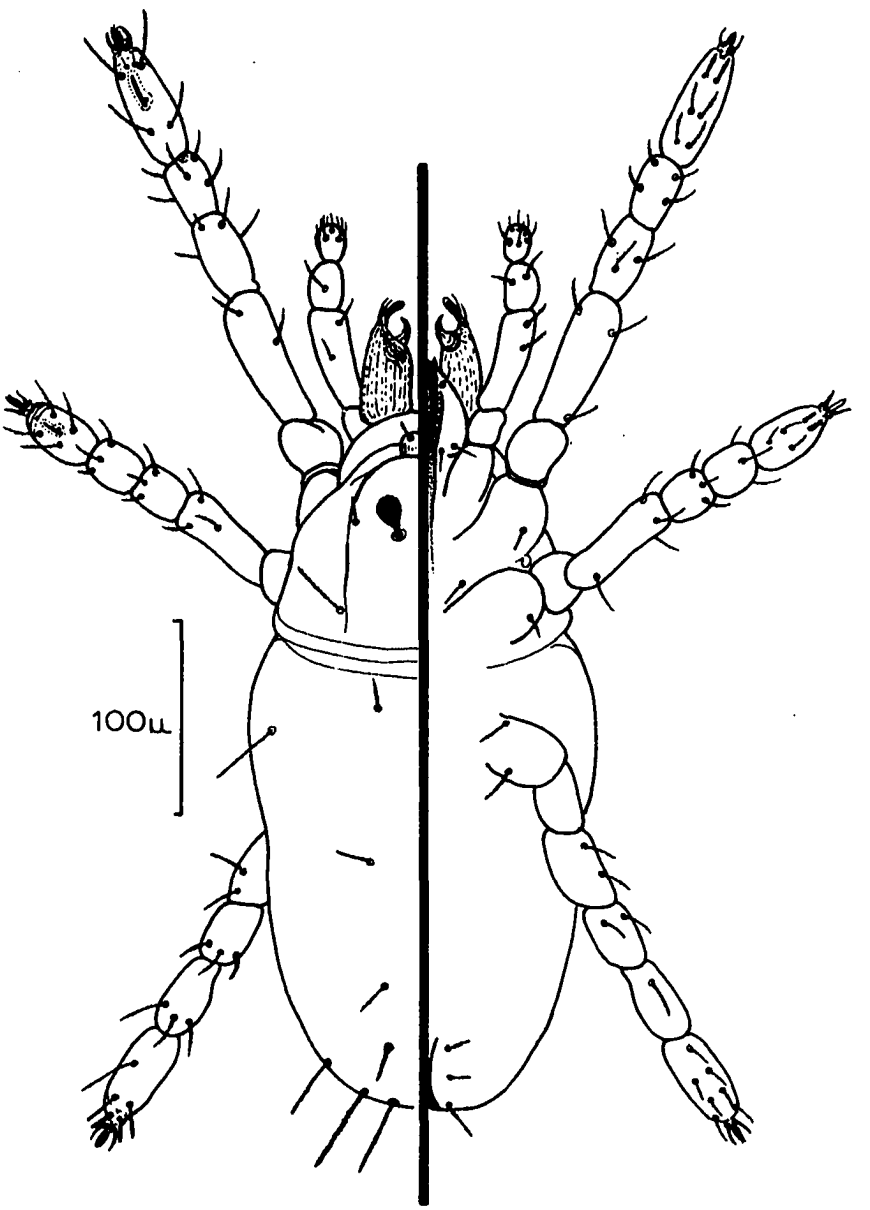

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Fig. 37. Coccorhagidia gressitti Womersley and Strandtmann. Protonymph, dorso-ventral aspect.

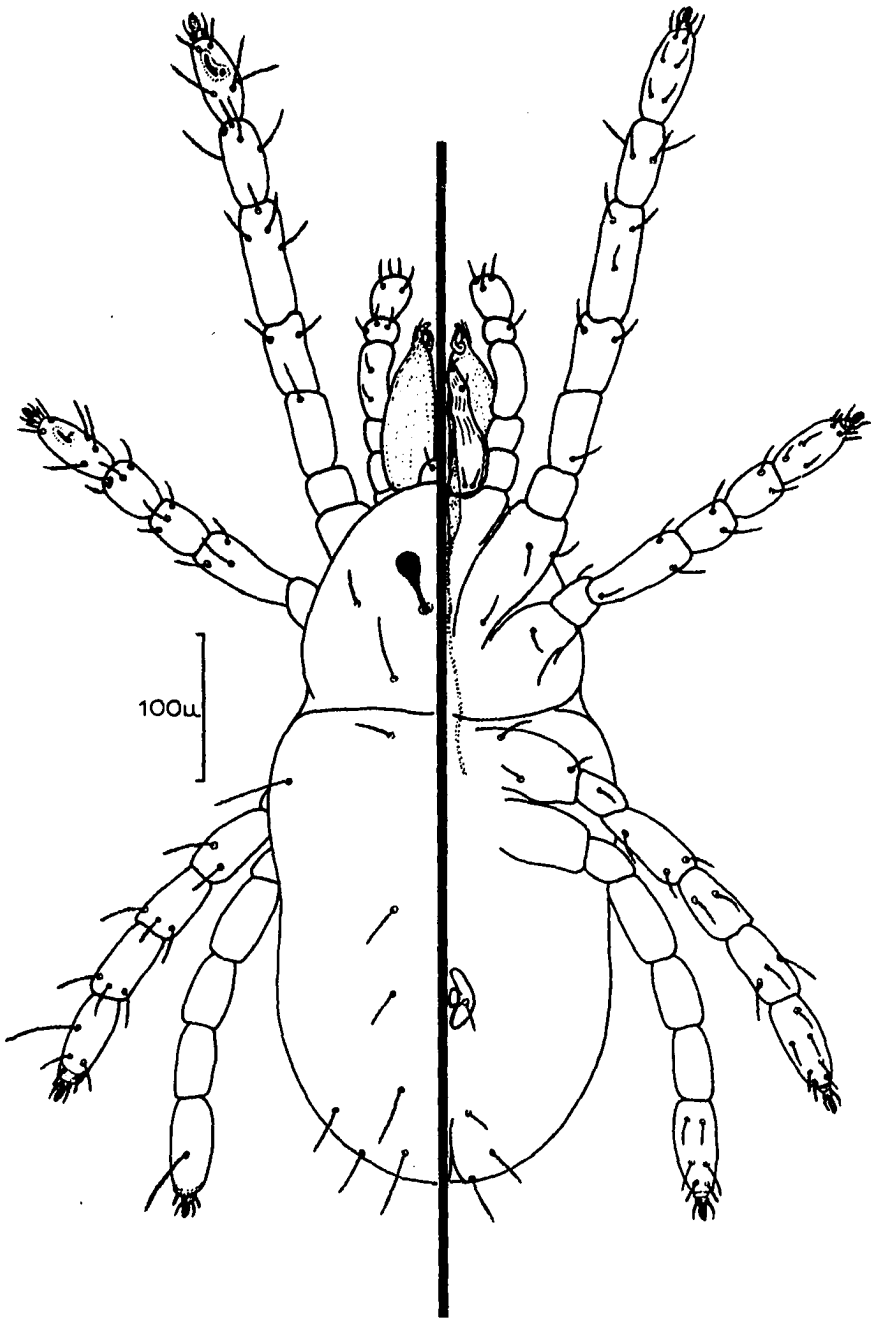
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Fig. 38. Coccorhagidia gressitti Womersley and Strandtmann. Deutonymph, dorso-ventral aspect.

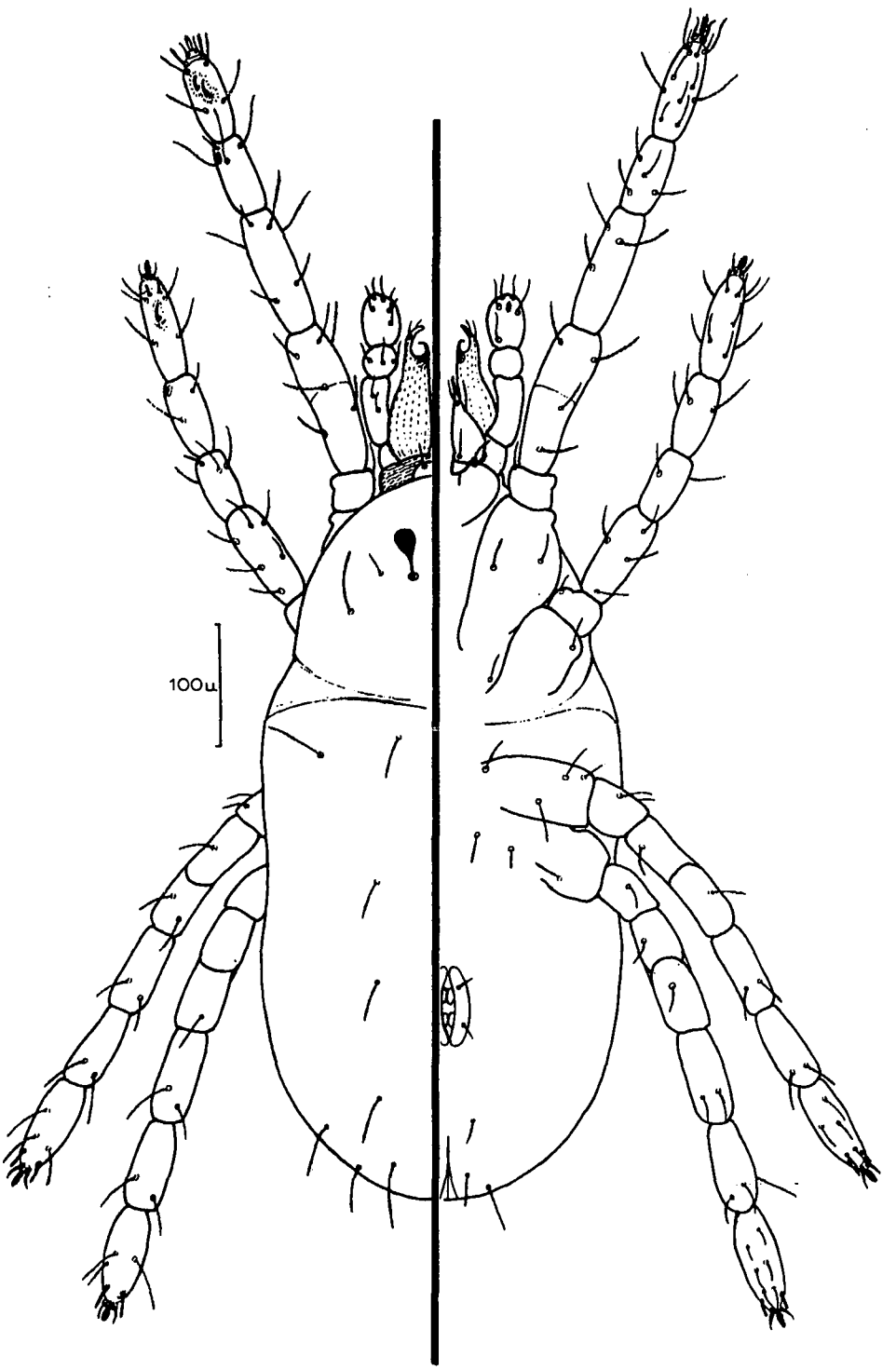

100u

Fig. 39. Coccorhagidia grossitti Womersley and Strandtmann. Tritonymph, dorso-ventral aspect.

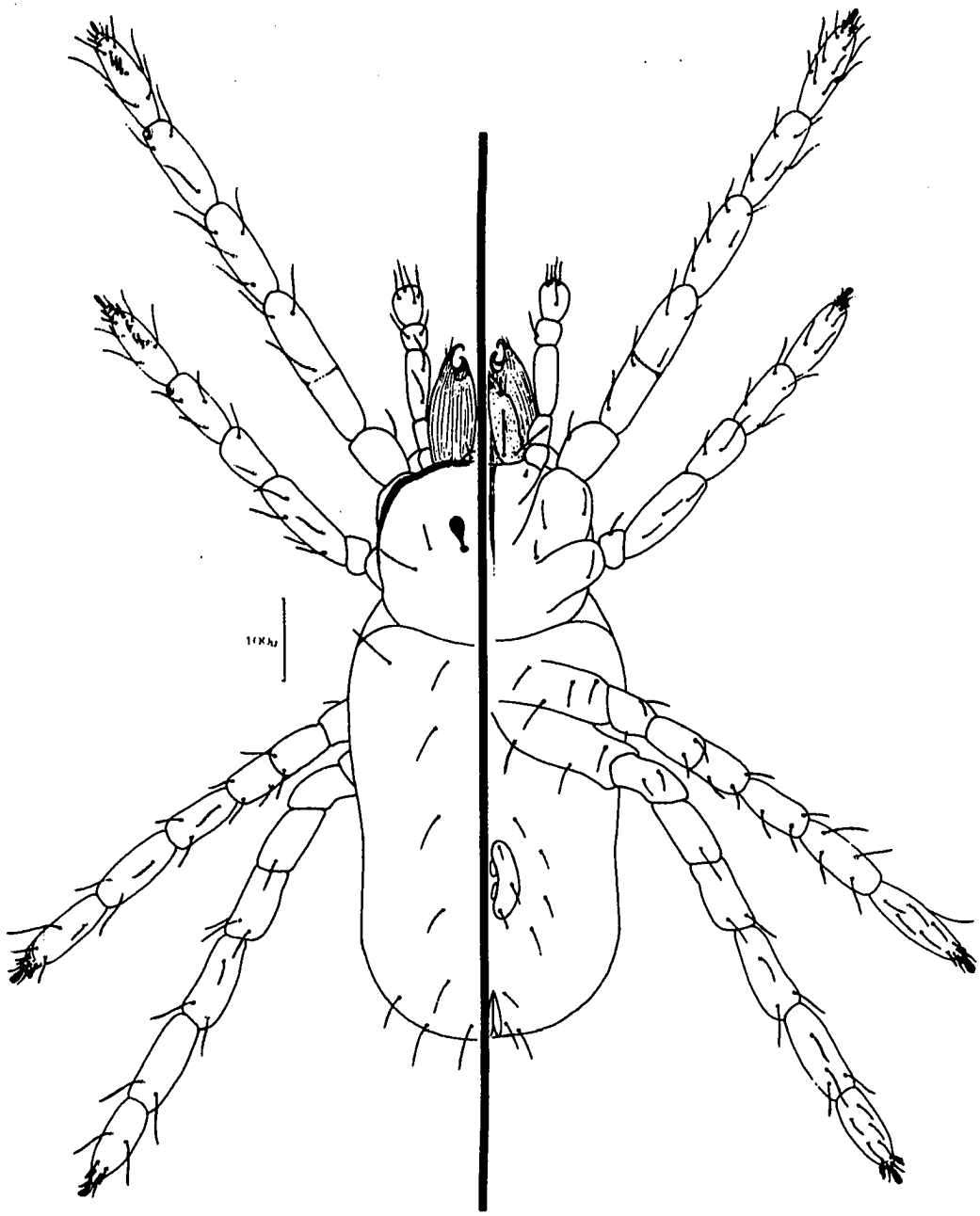
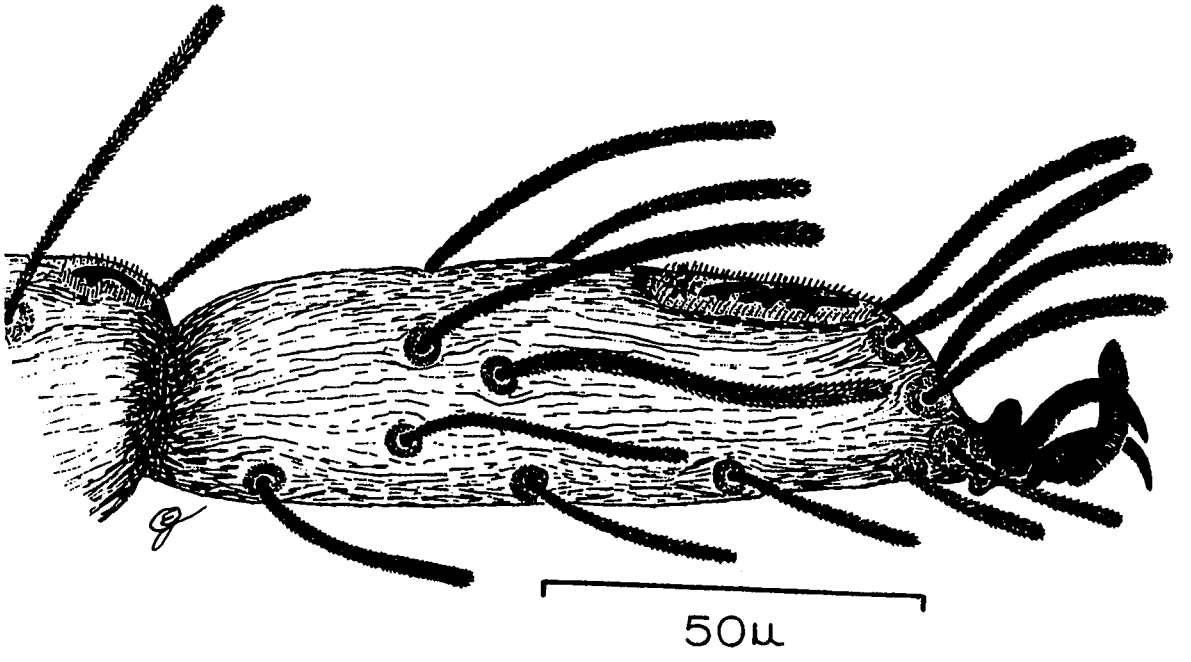


Fig. 40. Coccorhagidia gressitti Womersley and Strandtmann. Tritonymph, tarsus and tibia I, lateral.


50u

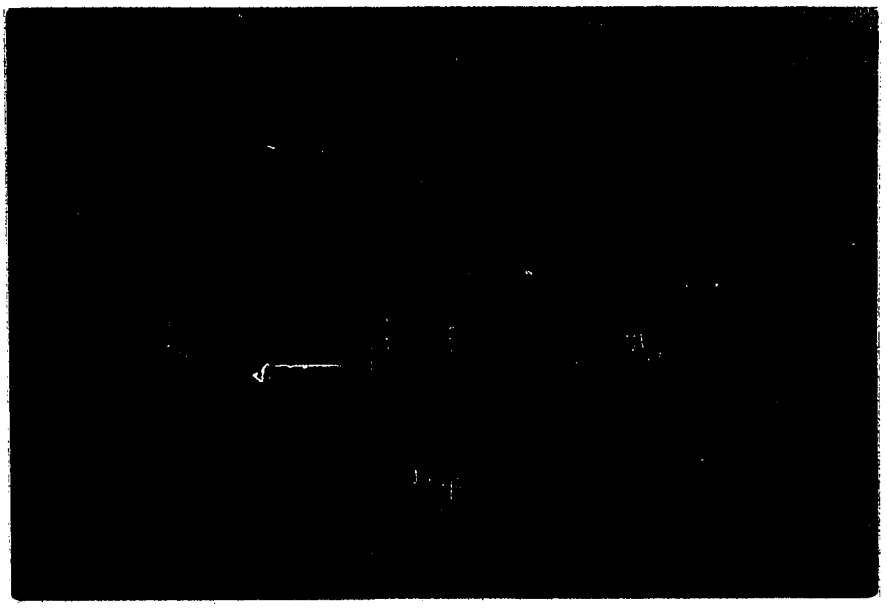


Fig. 41. Coccorhagidia gressitti Womersley and Strandtmann. Photomicrograph of adult ♂. Magnification: 20X.

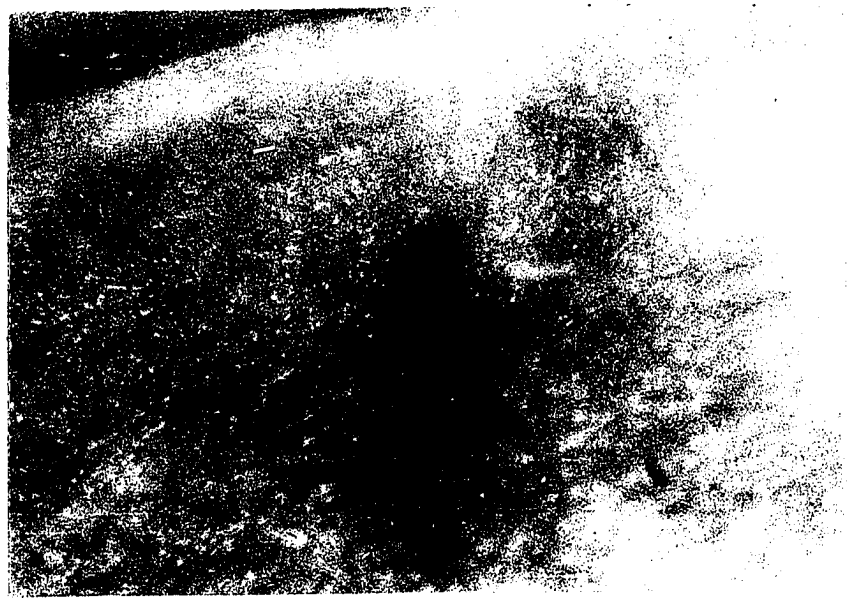


Fig. 42. Coccorhagidia gressitti Womersley and Strandtmann. Photomicrograph of adult holding and eating a Stereotydeus belli (Trouessart) tritonymph. Magnification: 20X.

HABITATS

Survival of soil mites at Hallett Station is affected by various factors and is dependent upon an intricate balance in their environmental relationships. Soil mites are probably poikilothermic or at the mercy of the great fluctuations of their environmental temperatures. They seem to have a physiological control of metabolic water enabling them to bind it or free it as the temperature becomes warmer or colder.

Since these organisms spend their entire lives in the tiny cracks and crevices in the soil, it follows that any study of their natural habitats must be undertaken at the microhabitat site and must involve soil temperature and water content regardless of the latter's physical state (i.e., solid, liquid or vapor).

Geiger (1950) described microclimate as weather conditions in the portion of the atmosphere from two meters to any depth in the soil. Pryor (1962) discussed microclimate and microhabitats at Hallett Station in view of soil temperature and moisture, wind, air temperature, light, and relative humidity. His basic problem was one that the writer also encountered, i.e., dependable field instruments for operation in the cold. Essentially the same instruments were used by the writer except for an automatic recorder in conjunction with the thermistorized telethermometer (Fig. 44a).

At the beginning of the project (October, 1965) soil temperature was the most intensively studied microclimatic factor. A preliminary study area was staked out near where Pryor (1962) conducted

a major portion of his studies (site A, Fig. 43). However, temperatures taken in and above the soil (Fig. 44b) were found to be rather uniform from one position and time of day to the same position and time of the next day. Essentially the data from this preliminary study served only to confirm Pryor's findings (Fig. 45).

Rudolph (1965) reported rock temperatures in excess of 32° C. During the 1966-1967 season the writer recorded a temperature of 33° C on 29 December 1966.

In an effort to learn more of the habits of S. belli in the field a dissection microscope was set up on the soil at site B. An ordinary d-cell flashlight was used for a light source. The microscope had a glass plate that could be removed from the stage thus permitting the objective to be lowered for viewing some distance below the base. This permitted observation of mites at approximately 5 cm depth along the sides of a small hole made in the soil surface by removal of rocks and stones.

After the soil materials were removed and the telethermometer probes placed in position, several clean rocks and stones were returned to the hole in a manner that permitted easy removal. The microscope oculars and objectives were covered with plastic when not in use. To remove effects of the observer's body heat the study site was observed from a downwind position thus eliminating its possible influence upon the mites' activities.

Mite mobility was the only function considered; twitching of legs or pedipalps, and idiosomal contractions were excluded. No

attempt was made to trace the mites' movements in soil strata.

Fig. 46 shows movement either as positive (M) or negative (0) at a soil depth of 5 cm on four dates during the 1966-1967 season. Soil surface temperature and air temperature (20 cm elevation), were recorded for supplementary information.

In an additional and similarly constructed hole two feet distant, a rubber hose of seven-eighth inch inside diameter was placed at a depth of 5 cm so that the Bendix electric psychrometer could be easily attached. The hole was then refilled with loose sandy soil and rocks that had been removed from it. A plastic sheet (ca. 1 m X 1 m) was placed over the area with edges sealed with sandy soil thereby forcing withdrawal of air from the soil only. Percent relative humidity readings were then taken at regular three-hour observations. The results of the humidity readings are shown in Fig. 47. Moisture in the soil at site B comes from melting snow fields on the sides and top of the Cape. On warm sunny days it runs in many small freshets and floods large areas around the site. The humidity in the soil undoubtedly results from the wetness and seepage of that water. Pryor (1962) commented: "Daily as well as seasonal, fluctuations in soil moisture content were characteristic of the area."

The extremely rocky slopes do not have the subsurface holding capacity found on the flats below. Consequently the moisture content in the soil is much less, resulting in sparse vegetation growth. Where the water flooded large areas on the flat, the daily temperature fluctuations would cause a nightly freeze of the water surface.

The permafrost level as determined by digging was at an average depth of 37 cm in such areas. On the slopes the permafrost level was at an approximate depth of 15 cm depending on the type of soil. If the basalt rocks were large and loose, the depth was greater; if fine and sandy, it was rather shallow. Level outcroppings with northern exposures became saturated with water from the freshets. In some cases if the outcropping was in a depression or if it was oriented so that it caught blowing snow from the prevailing SE winter wind, a semi-permanent snow field would develop. The area immediately below it and downwind would then show rich vegetative growth. Such an area is shown in Fig. 48. It was at that particular site that the new species of mite, Protereunetes paulinae Gless, was found. A close-up photo of the soil and vegetation is shown in Fig. 49a. Water seeping down the slope also seeped laterally in the fine sandy soil occurring below the gametophytes and rhizoids of B. argentium. The thick mats of vegetation would then soak up and hold the moisture (Fig. 49b).

However, in some flat areas it was impossible for the water to flow or to soak far enough to support the vegetation. In several of these areas the greatest amount of vegetation was always found on the downwind or north side of the snow field.

In an effort to follow the moisture more closely, a humidity station 5 cm above the soil surface was set up on the north side of the snow field and another similarly on the lower south side whereas wind instruments were set up in the center of the snow field. For four consecutive days in early January, 1968, relative humidity read-

ings, wind speed, and wind direction were taken every three hours. The accumulated data are shown in Fig. 50. It must be pointed out that the wind was constantly between 150 and 200 degrees. And, while the downwind side was approximately one meter higher in elevation the vegetative growth was three times as wide as that on the upwind side.

It has been observed that mites are active at temperatures well below freezing and that they are primarily dependent upon vegetation and secondarily dependent upon availability of usable water.

Water in liquid form is unavailable to plants except for very short periods of high temperatures during the summer months. Water melting from snow fields is soaked laterally and upward in heavy vegetative areas where organic material and soil particles have a holding capacity.

During periods of low temperatures water is sublimed from snow fields and carried in the form of humidity by slow moving air. The humidity formed in that manner is the source for hoarfrost condensation. When skies are clear and sunlight strikes the rock surfaces the hoarfrost is melted thus making additional water available for plants.

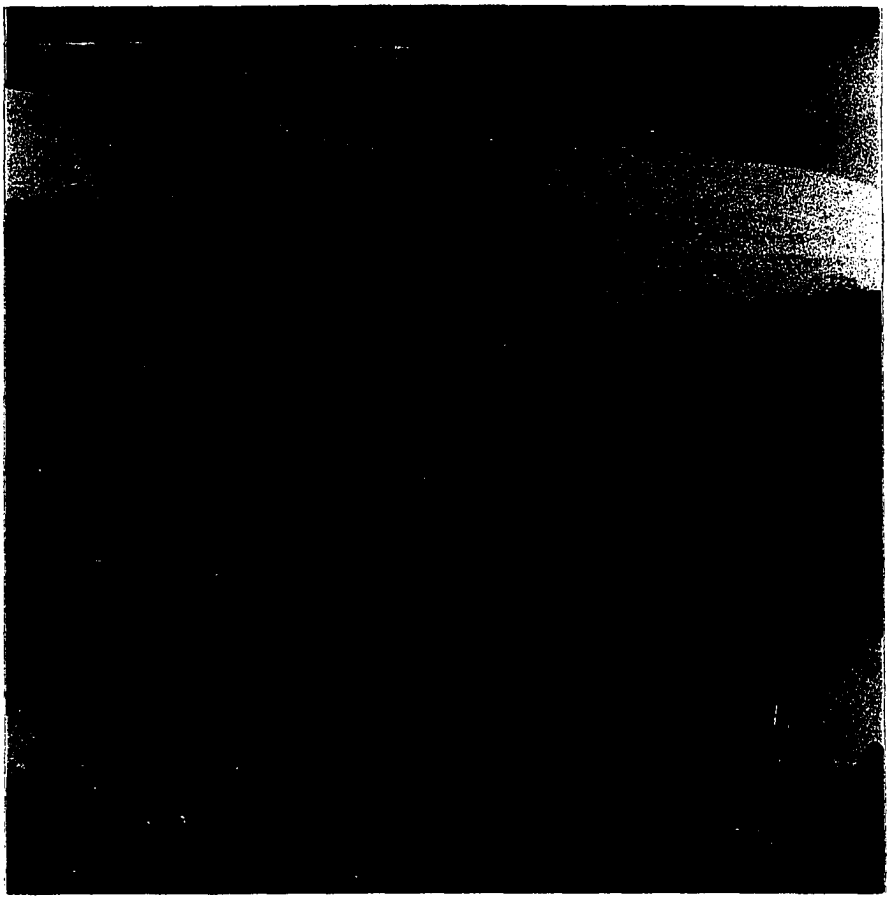


Fig. 43. Research site A due east from flats at a distance of ca. 50 m.

Fig. 44a. Model 47 scanning thermistor telethermometer (right) and model 80 recorder (left) in thermostatically controlled protective box. (Yellow Springs Instrument Co., Yellow Springs, Ohio.)

Fig. 44b. Research site A with thermistor temperature probes partly covered with snow.

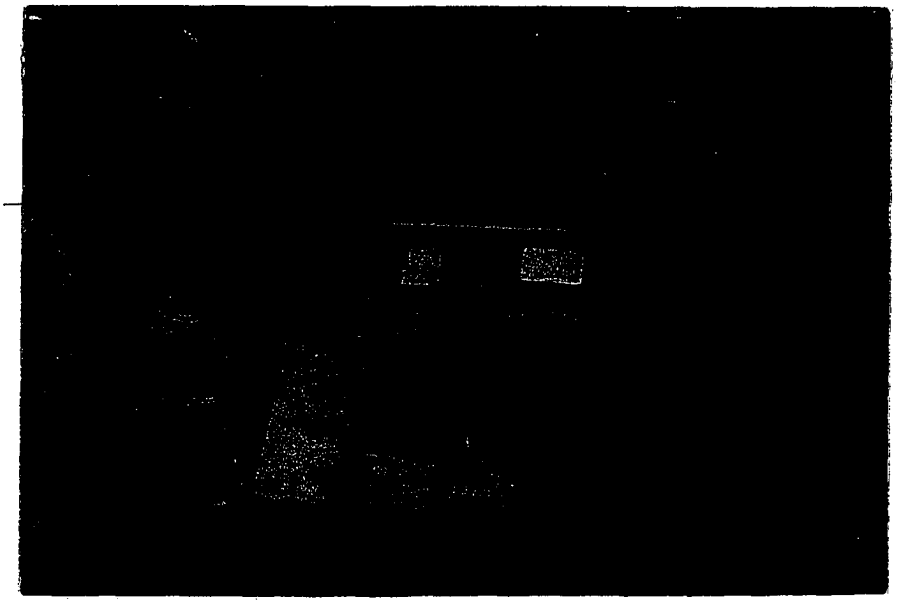


Fig. 45. Temperature at three-hour intervals for three 24-hour periods indicating surface retention of heat during the night time.

TEMPERATURE IN DEGREES F., SITE B. AIR ---------, SOIL SURFACE — — · — —,
AND 5 CM DEEP ————————. HALLETT STATION, ANTARCTICA.

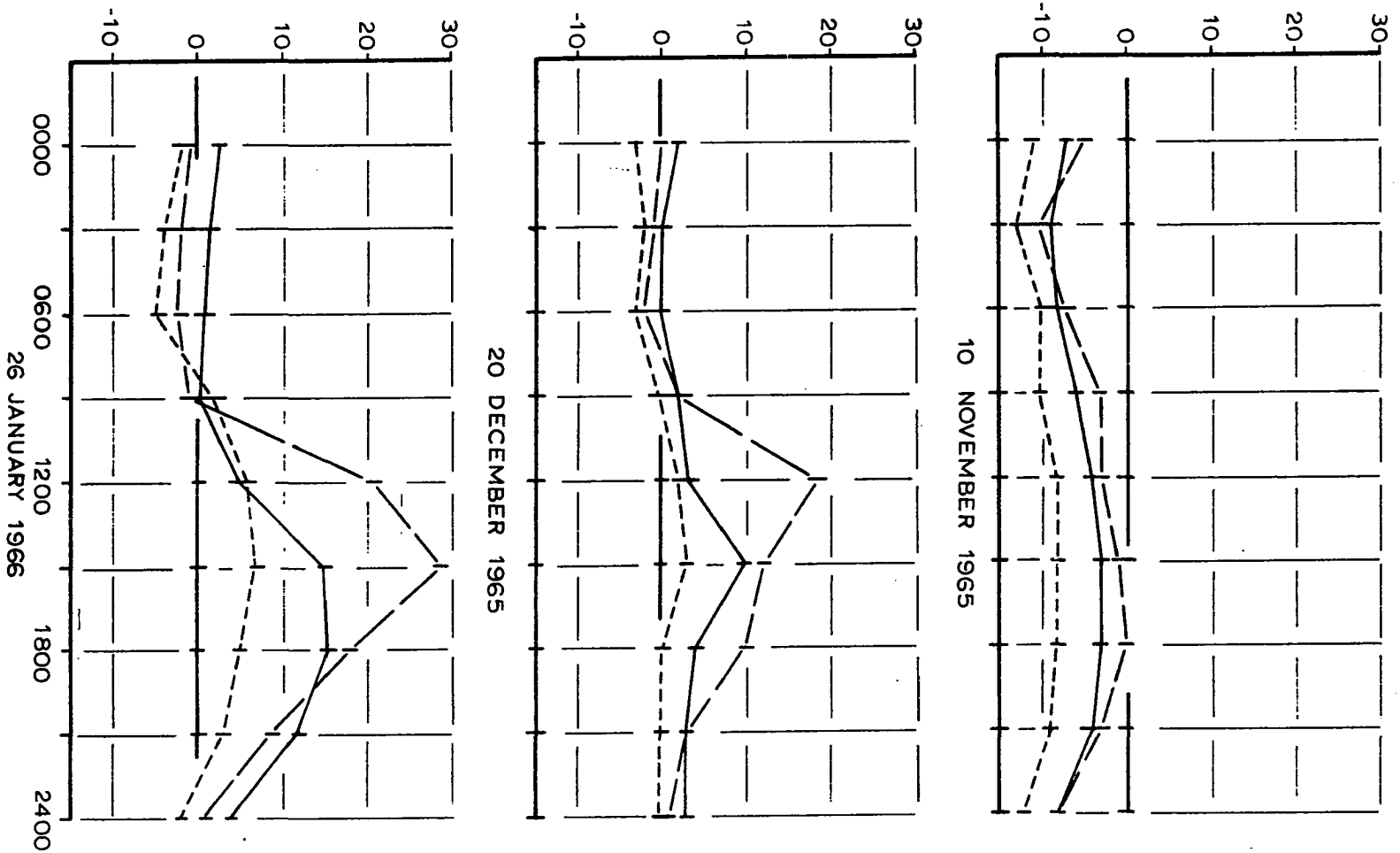


Fig. 46. Mite mobility at 5 cm soil depth.

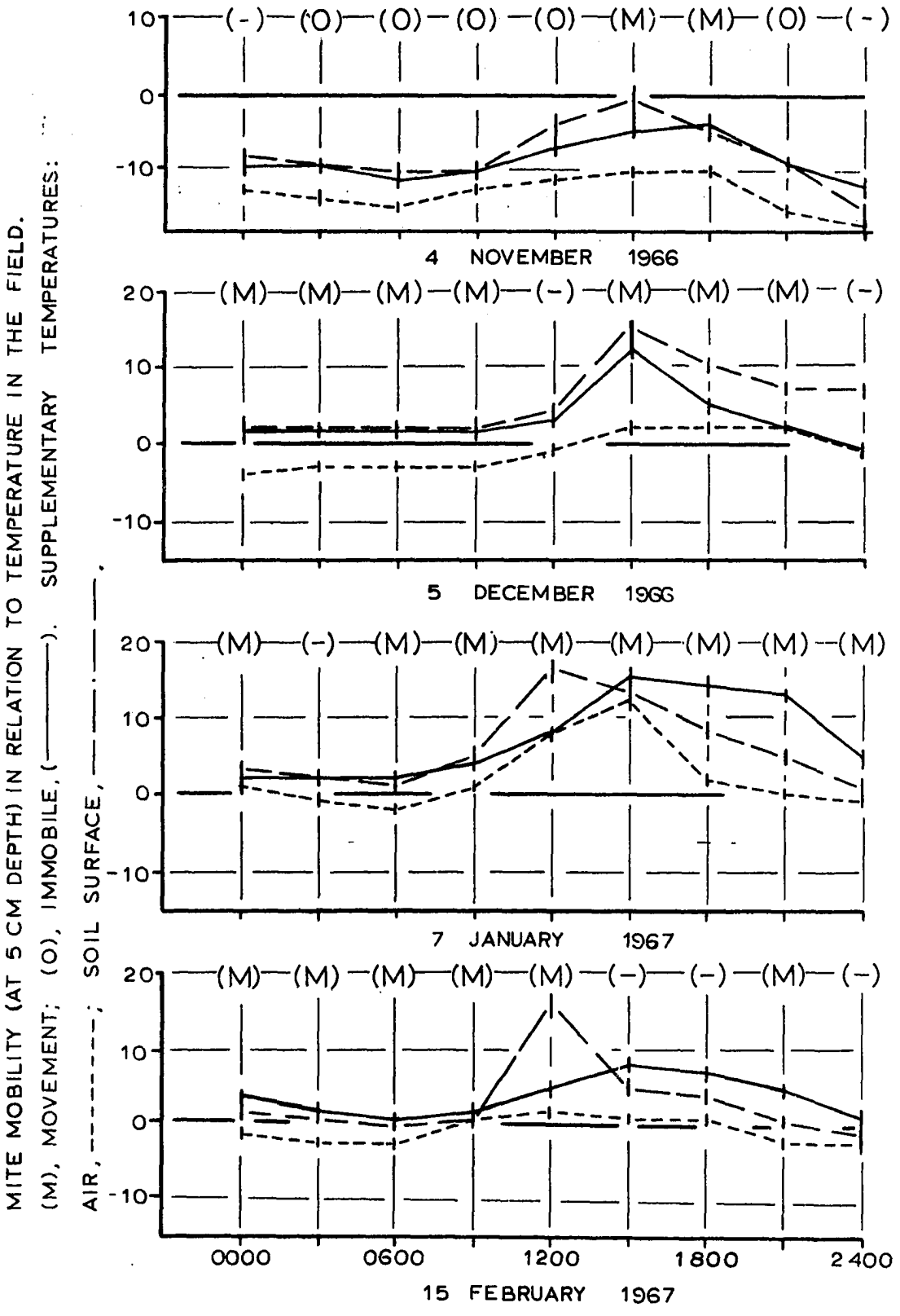
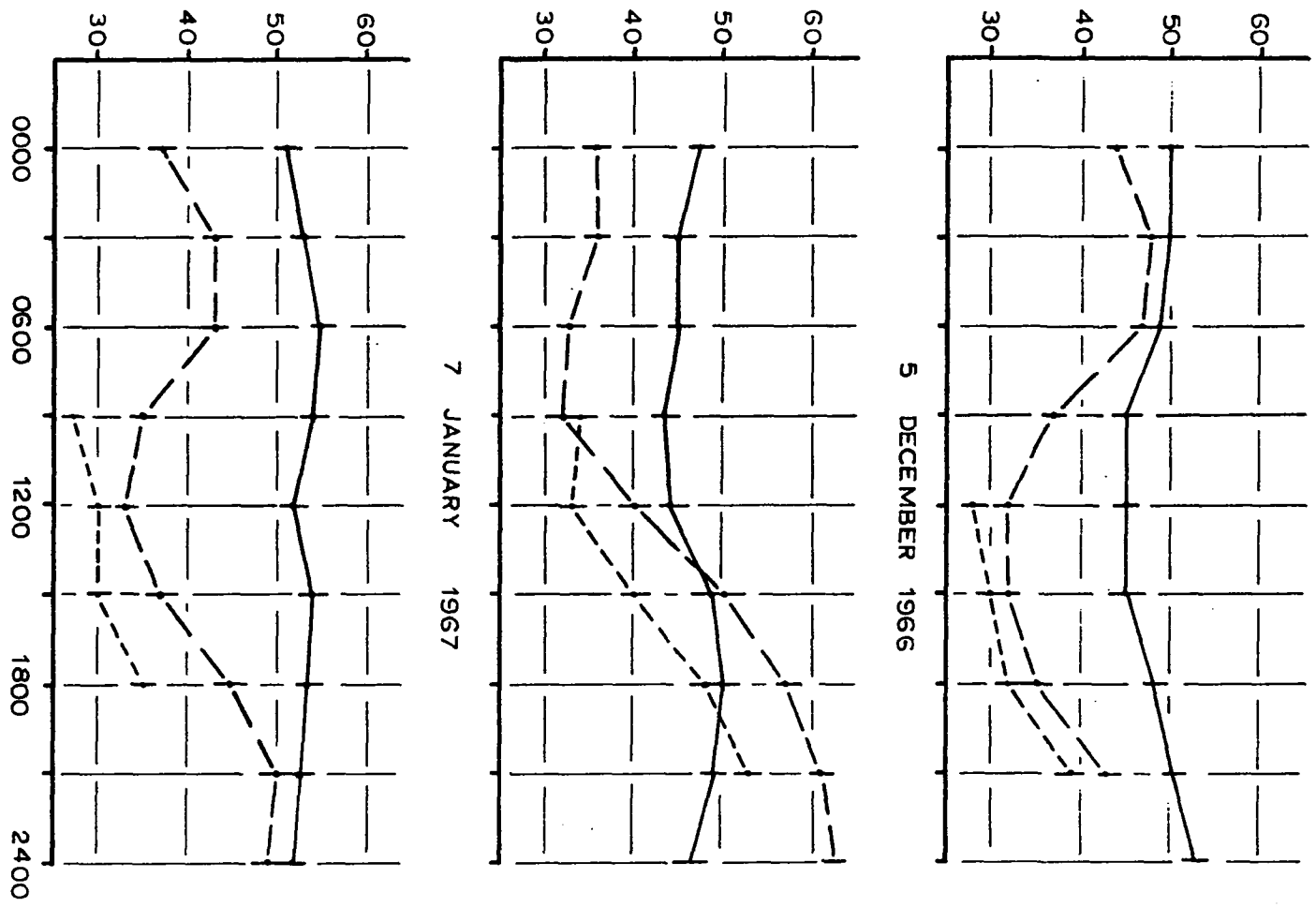

MITE MOBILITY (AT 5 CM DEPTH) IN RELATION TO TEMPERATURE IN THE FIELD.
(M), MOVEMENT; (O), IMMOBILE, (———). SUPPLEMENTARY TEMPERATURES:
AIR, - - - - - -; SOIL SURFACE, — · — · —.
10
0
-10
(-) (O) (O) (O) (O) (M) (M) (O) (-)
4 NOVEMBER 1966
20
10
0
-10
(M) (M) (M) (M) (-) (M) (M) (M) (-)
5 DECEMBER 1966
20
10
0
-10
(M) (-) (M) (M) (M) (M) (M) (M) (M)
7 JANUARY 1967
20
10
0
-10
(M) (M) (M) (M) (M) (-) (-) (M) (-)
0000 0600 1200 1800 2400
15 FEBRUARY 1967

Fig. 47. Comparison of percent relative humidity reading at site B.

SITE B RELATIVE HUMIDITY RECORDINGS AT THREE-HOURLY INTERVALS:
5 CM, ————; AIR AT 20 CM, - - - - - - - AND SOIL SURFACE — — · — — .



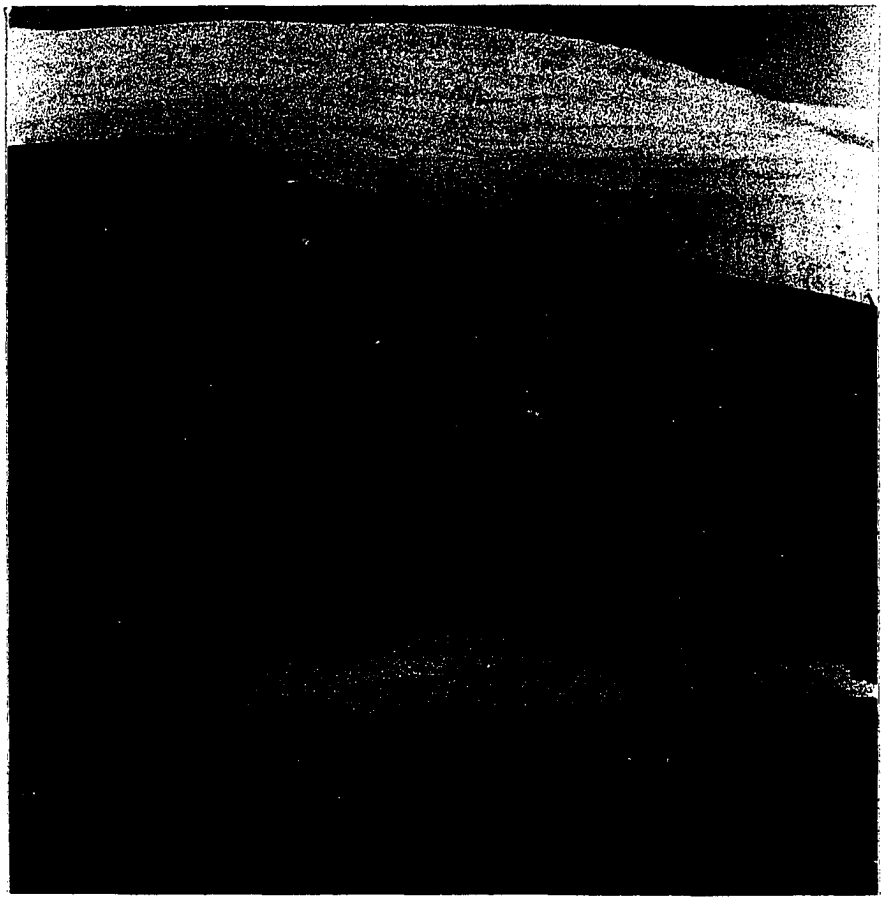
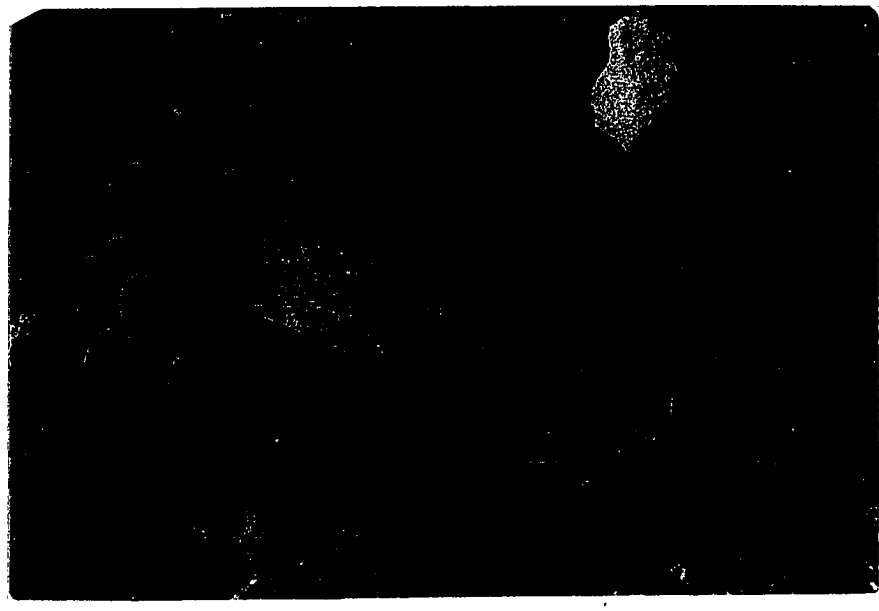


Fig. 48. Site where Protereunetes paulinae sp. n. was first collected 25 December 1966. Area is approximately 30 m SE of research site A and at 15 m elevation (see Fig. 3).

Fig. 49a. Microhabitat of Protereunetes paulinae sp. n. Partly dead and decaying clumps of B. argentium, Nostoc sp., ?Oscillatoria and the golden diatom of genus Navicula. Photograph taken near large rock in center of Fig. 48.

Fig. 49b. Vegetation mat (moss and algae) showing water flow and lateral seepage.



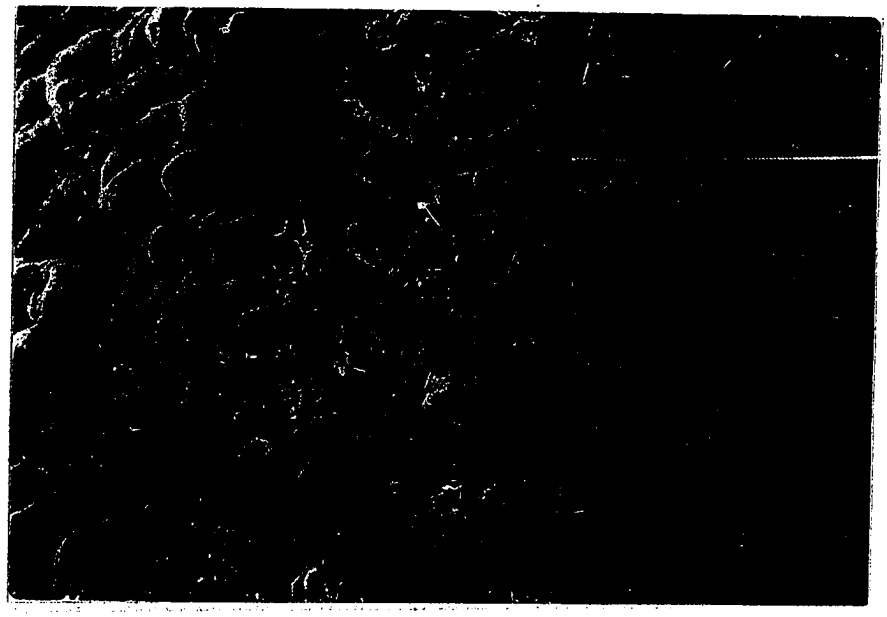
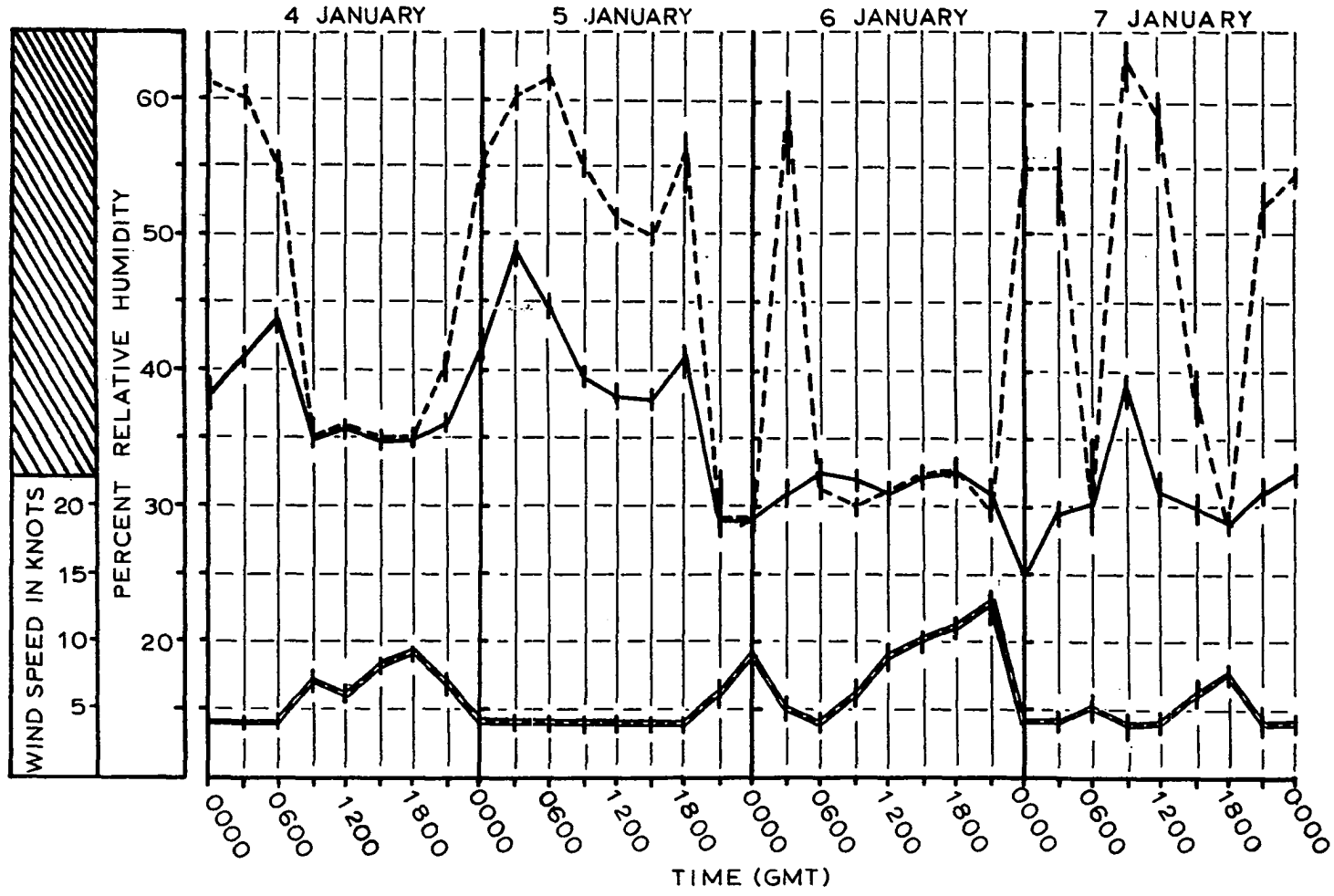


Fig. 50. Relative humidity in relation to wind speed and direction.

HUMIDITY UPWIND AND DOWNWIND OF A SNOWFIELD MEASURING 110 FEET DIAMETER.
WIND SPEED, ▬▬▬; HUMIDITY UPWIND, ——————; HUMIDITY DOWNWIND - - - - - - -.



NEW RECORD

Stereotydeus mollis Womersley and Strandtmann, 1963, Pacific Insects. 5(2):453.

Eight specimens found in soil flotations taken atop Hallett Peninsula and about two miles south of the tip of the peninsula were identified by the writer and confirmed by Strandtmann as Stereotydeus mollis. Three males, two females and three tritonymphs collected on 18 January 1967 are the first record of this species taken in North Victoria Land.

REFERENCES CITED

Atyeo, W. T. and P. C. Peterson. 1967. Astigmata (Sarcoptiformes): Proctophyllodidae, Avenzoariidae (feather mites). American Geophysical Union Antarctic Research Series 10:97-104.

Benes, N. S. 1959. Inside Antarctica No. 4: the Hallett story. Weatherwise 12:200-203.

Bold, H. C. 1957. Morphology of plants. Harper and Brothers, Publishers, New York, N. Y.

Bremner, J. M. 1965. Total nitrogen. Agronomy 9:1149-1178.

Cannon, H. G. 1941. On chlorazol black and some other new stains. Royal Microscopical Society Journal Series 3, 6:88-94.

Clay, T. and C. Moreby. 1967. Mallophaga (biting lice) and Anoplura (sucking lice). Part II. Keys and locality lists of Mallophaga and Anoplura. American Geophysical Union Antarctic Research Series 10:157-196.

Dater, Henry M. 1965a. History, Hallett Station from idea through the IGY. U.S. Antarctic Projects Officer Bulletin 6, No. 5:21-31.

Dater, Henry M. 1965b. Hallett Station from IGY to summer station status. U.S. Antarctic Projects Officer Bulletin 6, No. 6:19-32.

Dufek, G. 1959. What we've accomplished in Antarctica. National Geographic Magazine 116:526-557.

Evans, G. O., J. G. Sheals and D. MacFarlane. 1961. The terrestrial Acari of the British Isles. An introduction to their morphology, biology and classification. Volume 1. Alard and Son, Bartholemew Press, Dorking, England.

Gannutz, T. 1966. Discussion and notes on lichen physiology at Hallett Station, Antarctica. E. E. Gless records, Department of Zoology and Entomology, Iowa State University, Ames, Iowa.

Geiger, R. 1950. The climate near the ground. Harvard University Press, Cambridge, Mass.

Gless, Elmer E. 1967. Notes on the biology of Coccorhagidia gressitti Womersley and Strandtmann. American Geophysical Union Antarctic Research Series 10:321-323.

Gressitt, J. L. 1961. Problems in the zoogeography of pacific and antarctic insects. Pacific Insects Monograph 2:1-127.

Gressitt, J. L. 1967. Introduction. American Geophysical Union Antarctic Research Series 10:1-23.

Gressitt, J. L. 1968. Discussion and notes on entomological research in Antarctica at Bernice P. Bishop Museum, Honolulu, Hawaii. E. E. Gless records, Department of Zoology and Entomology, Iowa State University, Ames, Iowa.

Gressitt, J. L. and J. Shoup. 1967. Ecological notes on free-living mites in North Victoria Land. American Geophysical Union Antarctic Research Series 10:307-320.

Harrington, H. J. 1958. Nomenclature of rock units in the Ross Sea region, Antarctica. Nature 182-290.

Lange, O. 1966. Discussion and notes with keys to lichens at Hallett Station, Antarctica. E. E. Gless records, Department of Zoology and Entomology, Iowa State University, Ames, Iowa.

Pryor, M. E. 1962. Some environmental features of Hallett Station, Antarctica, with special reference to soil arthropods. Pacific Insects 4:681-728.

Reid, B. E. 1964. The Cape Hallett adélie penguin rookery - its size, composition and structure. Records of the Dominion Museum 5, No. 4:11-37.

Rudolph, E. D. 1965. Lichen ecology and microclimate studies at Cape Hallett, Antarctica. International Biometeorological Congress, Pau, France, 1963, Proceedings 3, Vol. 2:900-910.

Rudolph, E. D. 1968. Telephone conversation notes and letter concerning lichen nomenclature at Hallett Station, Antarctica. E. E. Gless records, Department of Zoology and Entomology, Iowa State University, Ames, Iowa.

Russell, Darrell A. 1967. Laboratory manual for soil fertility students: modifications by L. R. Frederick and J. R. Murphy. Agronomy Department, Iowa State University, Ames, Iowa.

Salt, G. and F.S.J. Hollick. 1944. Studies of wire-worm populations. 1. A census of wire-worms in pasture. Annals of Applied Biology 31:52-64.

Solomon, M. E. 1951. Control of humidity with potassium hydroxide, sulfuric acid, or other solutions. Entomological Research Bulletin 42:543-554.

Strandtmann, R. W. 1967. Terrestrial Prostigmata (trombidiform mites). American Geophysical Union Antarctic Research Series 10:51-103.

Strandtmann, R. W. 1968. Morphology of Eupodes wisei Womersley and Strandtmann, 1963 discussed via letter dated 4 June 1968. E. E. Gless records, Department of Zoology and Entomology. Iowa State University, Ames, Iowa.

U.S. Naval Support Force. Antarctica. Commander. 1956. Report of Operation Deep Freeze I, 1955-1956. Mimeograph. Archives of Division of Environmental Sciences, National Science Foundation, Washington, D.C.

U.S. Navy. Secretary. 1960. Sailing directions for Antarctica: 1960. U.S. Hydrographic Office H.O. Publication No. 27 (formerly H.O. Publication No. 139).

U.S. Weather Bureau. 1959. World weather records, 1941-1950. U.S. Government Printing Office, Washington, D.C.

U.S. Weather Bureau. 1962. Climatological Data for Antarctic Stations No. 1. July 1957-December 1958.

Wallwork, J. A. 1962. Maudhemia petronia n. sp. (Acari: Oribatei) an oribatid mite from Antarctica. Pacific Insects 4:865-868.

Wallwork, J. A. 1962. Notes on the genus Pertorgunia Dalenius, 1958 from Antarctica and Macquarie (Acari: Oribatei). Pacific Insects 4:881-885.

Wise, K.A.J. 1967. Collembola (springtails). American Geophysical Union Antarctic Research Series 10:123-148.

Womersley, H. and R. W. Strandtmann. 1963. On some free-living prostigmatic mites of Antarctica. Pacific Insects 5:451-472.

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Thank you to Dr. R. W. Strandtmann whose work in antarctic acarology served as a basis for this and for his assistance in identification of species. Thanks also to Dr. G. A. Llano, Program Director of Antarctic Biology, National Science Foundation, for his assistance and encouragement during the entire three years.

The facilities at our library at Iowa State University are wonderful. The requirements of this research project, though different than those of the usual ISU student, were entirely met.

I wish to extend my thanks to the sailors of Operation Deep Freeze. They, the real "Hallett Heros", put in many lonely hours and hard work in support of this study.

Finally, I want to say thank you to Lisa and Tommy our two children, ages five and four respectively, for sharing Daddy with Antarctica and the mites.

APPENDIX

Table 5. Listing of flora and fauna found in transect (see section on transect data and Fig. 3)

					Fauna					
					Mites					
Collection		Flora			Coccorhagidia		Stereotydeus		Eupodes	
Number	Date	Algae	Moss	Lichen	Asp	Flot	Asp	Flot	Asp	Flot
1	9 Jan.	+	0	0	1	0	0	0	0	0
2	9 Jan.	+	0	0	0	1	0	0	0	0
3	9 Jan.	+	0	0	1	0	1	0	0	0
4	9 Jan.	+	0	0	0	0	0	0	0	0
5	9 Jan.	+	0	0	0	0	0	0	0	0
6	9 Jan.	+	0	0	1	0	0	0	0	0
7	10 Jan.	0	0	0	0	1	0	0	0	0
8	10 Jan.	0	0	0	0	0	0	0	0	0
9	10 Jan.	+	0	0	0	0	0	1	0	0
10	10 Jan.	0	0	0	0	0	0	0	1	0
11	10 Jan.	+	0	0	1	1	0	0	0	0
12	10 Jan.	+	0	0	4	0	0	0	0	1
13	10 Jan.	0	0	0	0	0	0	0	0	2
14	10 Jan.	0	0	0	1	0	0	0	0	5+
15	11 Jan.	+	0	0	0	1	0	0	0	0
16	11 Jan.	0	0	0	0	0	0	1	0	0
17	11 Jan.	0	0	0	1	0	0	0	0	0
18	11 Jan.	0	0	0	0	1	0	0	0	0
19	11 Jan.	0	0	0	0	0	0	0	0	0
20	12 Jan.	0	0	0	0	1	1	4	0	-
21	12 Jan.	+	0	0	0	0	4	1	0	-

Fauna (continued)												
Mites (continued)						Collembola[a]					
Nanorchestes		Tydeus		Protereunetes		A		B		C	
Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot
0	0	0	0	0	0	2	12	0	0	0	0
0	1	0	0	0	0	4	20+	0	0	0	0
0	1	0	0	0	0	10+	40+	0	0	0	0
0	2	0	0	0	0	1	6	0	0	0	0
0	1	0	0	0	0	2	2	0	0	0	0
0	3	0	0	0	0	1	7	0	0	0	0
0	2	0	0	0	0	4	6	0	0	0	0
0	1	0	0	0	0	5	10+	0	0	0	0
0	0	0	0	0	0	4	10+	0	0	0	0
0	2	0	0	0	0	2	10+	0	0	0	0
0	4	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	1	4	0	0	0	0
0	1	0	0	0	0	1	10+	0	0	0	0
0	1	0	0	0	0	0	2	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	2	8	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	-	0	0	0	0	5	-	0	-	0	-
0	-	0	0	0	0	0	-	0	-	0	-

Table 5. continued

Collection Number	Date	Flora			Fauna					
					Mites					
					Coccorhagidia		Stereotydeus		Eupodes	
		Algae	Moss	Lichen	Asp	Flot	Asp	Flot	Asp	Flot
22	12 Jan.	+	0	0	2	0	10+	20+	0	6
23	12 Jan.	0	0	0	2	0	50+	20+	0	0
24	12 Jan.	0	0	0	0	1	4	0	0	0
25	12 Jan.	0	0	0	0	0	0	0	0	0
26	12 Jan.	0	0	0	4	0	0	2	0	0
27	12 Jan.	0	0	0	4	1	1	4	0	0
28	12 Jan.	+	0	0	1	1	4	0	0	0
29	12 Jan.	0	0	0	0	1	0	0	0	0
30	12 Jan.	0	0	0	0	0	0	0	0	0
31	12 Jan.	+	0	0	1	0	0	0	0	0
32	12 Jan.	+	0	0	1	0	0	1	0	0
33	12 Jan.	-	-	-	-	-	-	-	-	-
34	12 Jan.	-	-	-	-	-	-	-	-	-
35	13 Jan.	+	-	-	1	1	4	10+	2	0
36	13 Jan.	+	+	-	0	0	10+	5	1	0
37	13 Jan.	-	+	-	0	0	10+	4	4	0
38	15 Jan.	+	+	-	0	4	50+	2	10+	4
39	15 Jan.	+	+	-	0	4	50+	1	10+	5
40	15 Jan.	+	+	-	0	1	50+	10	10+	5
41	16 Jan.	+	+	-	0	1	50+	1	10+	5
42	16 Jan.	+	+	+	0	1	50+	4	10+	5

Fauna (continued)												
Mites (continued)						Collembola						
Nanorchestes		Tydeus		Protereunetes		A		B		C		
Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot
0	1	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	4	0	0	0	0	0
0	0	0	0	0	0	6	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	0	0	0	0	0
0	0	0	0	0	0	2	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	C	10+	++[b]	0	++	0	0
0	0	0	0	0	0	50+	++	0	++	0	0
0	0	0	0	0	0	50+	++	0	++	0	0
-	-	0	0	0	0	-	-	-	-	-	-
-	-	0	0	0	0	-	-	-	-	-	-
0	0	1	6	0	0	4	0	0	0	0	0
0	0	1	10+	0	0	2	0	0	0	0	0
-	-	4	10+	0	0	-	20+	0	0	0	0
-	-	7	10+	0	0	-	20+	0	0	0	0
-	-	-	10+	0	0	-	20+	0	0	0	0
-	-	-	10+	0	0	-	20+	0	0	0	0
-	-	-	20+	0	0	-	100+	0	0	0	0
-	-	-	20+	0	0	-	10+	0	10+	0	10+

Table 5. continued

Collection Number	Date	Flora			Fauna: Mites: Coccorhagidia		Stereotydeus		Eupodes	
		Algae	Moss	Lichen	Asp	Flot	Asp	Flot	Asp	Flot
43	16 Jan.	+	+	+	0	1	50+	15	10+	5
44	16 Jan.	-	+	-	0	0	50+	20+	10+	5
45	16 Jan.	+	-	-	0	0	50+	20+	10+	6
46	16 Jan.	+	-	-	0	1	100+	20+	10+	8
47	16 Jan.	+	+	-	1	1	50+	10+	10+	10
48	16 Jan.	+	-	-	2	4	100+	10+	10+	5
49	16 Jan.	+	-	-	4	6	100+	10+	10+	5
50	16 Jan.	+	-	-	1	1	50+	10+	10+	5
51	17 Jan.	+	-	-	1	-	20+	3	7	2
52	17 Jan.	+	+	-	0	4	10+	5	6	1
53	17 Jan.	+	+	-	2	1	10	8	5	1
54	17 Jan.	+	+	+	4	2	10	11	7	10+
55	17 Jan.	+	+	+	1	0	20+	5	2	1
56	17 Jan.	+	+	-	2	1	5	2	0	1
57	17 Jan.	+	-	-	1	4	10	12	0	4
58	17 Jan.	+	-	-	0	2	5	2	0	2
59	17 Jan.	+	-	-	1	4	5	5	0	1
60	17 Jan.	-	-	-	0	1	2	2	0	1
61	17 Jan.	+	-	-	0	1	0	4	0	1
62	18 Jan.	+	-	-	0	1	2	0	0	1
63	18 Jan.	+	-	-	0	0	3	0	0	1

Fauna (continued)												
Mites (continued)						Collembola					
Nanorchestes		Tydeus		Protereunetes		A		B		C	
Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot
-	-	-	20+	0	0	-	20+	0	10+	0	0
-	-	-	10+	0	0	-	100+	0	0	0	0
-	-	-	10	0	0	-	10+	0	0	0	0
-	-	-	10	0	0	-	10+	0	0	0	0
-	-	-	10	0	0	-	10+	0	20+	0	20+
-	-	-	10	0	0	-	100+	0	0	0	0
-	-	-	10	0	0	-	100+	0	20+	0	20+
-	-	-	10	0	0	-	100+	0	0	0	0
-	-	-	10+	0	0	-	100+	0	0	0	0
-	-	-	10+	0	0	-	100+	0	10+	0	10+
-	-	-	10+	0	0	-	100+	0	10+	0	50+
-	-	-	10+	0	0	-	++	0	10+	0	75+
-	-	-	10+	0	0	-	++	0	10+	0	100+
-	-	-	10+	0	0	-	++	0	10+	0	100+
-	-	-	20+	0	0	-	++	0	10+	0	100+
-	-	-	20+	0	0	-	++	0	10+	0	100+
-	-	-	20+	0	0	-	++	0	10+	0	100+
-	-	-	5	0	0	-	100+	0	5	0	20+
-	-	-	5	0	0	-	50+	0	0	0	10+
-	-	-	4	0	0	-	50+	0	5	0	0
-	-	-	0	0	0	-	20+	-	5	-	3

Table 5. continued

Collection Number	Date	Flora			Fauna: Mites: Coccorhagidia		Stereotydeus		Eupodes	
		Algae	Moss	Lichen	Asp	Flot	Asp	Flot	Asp	Flot*
64	18 Jan.	+	-	-	0	0	1	3	0	4
65	18 Jan.	+	-	-	0	0	1	0	0	1
66	18 Jan.	+	-	-						
67	18 Jan.	+	-	-						
68	18 Jan.	+	-	-						
69	18 Jan.	+	-	-						
70	19 Jan.	-	-	-	W A T E R S T A N D I N G					
71	19 Jan.	-	-	-						
72	19 Jan.	-	-	-						
73	19 Jan.	-	-	-						
74	19 Jan.	-	-	-						
75	19 Jan.	+	+	-	0	2	4	7	1	3
76	20 Jan.	+	+	+	1	4	20+	10+	10+	5+
77	20 Jan.	+	+	+	4	2	20+	10+	10+	5+
78	20 Jan.	+	+	-	0	1	20+	10+	10+	5+
79	20 Jan.	+	-	-	0	0	20+	10+	10+	5+
80	20 Jan.	+	-	-	0	0	10+	3	5	5+
81	20 Jan.	+	-	-	0	0	5	1	1	1
82	20 Jan.	+	-	-	0	1	2	1	0	0
83	20 Jan.	+	-	-	W A T E R S T A N D I N G					
84	20 Jan.	+	-	-						

Fauna (continued)												
Mites (continued)						Collembola						
Nanorchestes		Tydeus		Protereunetes		A		B		C		
Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot
-	-	-	0	0	0	-	10+	-	5	-	4
-	-	-	0	0	0	-	10+	-	5	-	4
-	1	-	7	0	0	-	100+	-	-	-	50+
-	-	-	20+	0	0	-	++	-	-	-	50+
-	-	-	50+	0	0	-	++	-	-	-	50+
-	-	-	50+	0	0	-	++	-	-	-	50+
-	-	-	50+	0	0	-	100+	-	-	-	50+
-	-	-	50+	0	0	-	100+	-	-	-	20+
-	-	-	50+	0	0	-	50+	-	-	-	20+
-	-	-	20+	0	0	-	20+	-	-	-	10+

Table 5. continued

Collection Number	Date	Flora			Fauna: Mites					
					Coccorhagidia		Stereotydeus		Eupodes	
		Algae	Moss	Lichen	Asp	Flot	Asp	Flot	Asp	Flot
85	20 Jan.	+	-	-						
86	20 Jan.	+	-	-	W A T E R S T A N D I N G					
87	21 Jan.	+	-	-	0	1	0	5	0	2
88	21 Jan.	+	-	-	0	2	0	4	0	1
89	21 Jan.	+	-	-	0	0	4	10+	0	1
90	21 Jan.	+	+	-	1	1	10+	10+	2	1
91	21 Jan.	+	+	-	1	4	10+	5+	5+	5+
92	21 Jan.	+	+	-	0	1	20+	10+	10+	5+
93	21 Jan.	+	+	-	0	0	20+	5+	5+	5+
94	21 Jan.	+	-	-	0	1	20+	5+	5+	5+
95	22 Jan.	+	-	-	0	1	20+	10+	1	2
96	22 Jan.	+	-	-	0	0	10+	10+	0	0
97	22 Jan.	+	-	-	0	0	5	10+	0	0
98	22 Jan.									
99	22 Jan.									
100	22 Jan.	W A T E R S T A N D I N G								
101	22 Jan.									
102	22 Jan.	+	-	-	0	0	10+	5	0	1
103	22 Jan.	+	+	-	0	0	20+	2	0	2
104	22 Jan.	+	-	-	0	0	20+	6	0	0
105	22 Jan.	+	-	-	0	1	0	4	2	1

Fauna (continued)												
Mites (continued)						Collembola						
Nanorchestes		Tydeus		Protereunetes		A		B		C		
Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot
-	0	-	20+	-	1	-	10+	-	-	-	20+
-	0	-	10+	-	3	-	10+	-	-	-	20+
-	1	-	20+	-	1	-	10+	-	-	-	20+
-	0	-	20+	-	0	-	10+	-	-	-	20+
-	0	-	20+	-	0	-	100+	-	-	-	20+
-	0	-	20+	-	0	-	100+	-	-	-	50+
-	0	-	20+	-	0	-	++	-	-	-	100+
-	0	-	50+	-	1	-	100+	-	-	-	100+
-	0	-	50+	-	0	-	100+	-	-	-	50+
-	0	-	20+	-	0	-	100+	-	-	-	25+
-	0	-	20+	-	1	-	++	-	-	-	100+
-	0	-	10+	-	0	-	++	-	-	-	100+
-	0	-	10+	-	0	-	100+	-	-	-	100+
-	0	-	10+	-	0	-	100+	-	-	-	100+
-	0	-	10++	-	0	-	25+	-	-	-	100+

Table 5. continued

Collection Number	Date	Flora			Fauna: Mites: Coccorhagidia		Stereotydeus		Eupodes	
		Algae	Moss	Lichen	Asp	Flot	Asp	Flot	Asp	Flot
106	23 Jan.	+	-	-	0	0	0	4	1	20+
107	23 Jan.	+	-	-	1	1	5	5	0	10+
108	23 Jan.	+	-	-	2	4	10	5	0	10+
109	23 Jan.	+	-	-	1	6	5	1	0	10+
110	23 Jan.	+	-	-	3	7	5	1	0	5+
111	23 Jan.	0	-	-	1	0	5	6	0	2
112	23 Jan.	+	-	-	0	1	5	8	1	10+
113	23 Jan.	+	-	-	0	0	10	8	1	5
114	23 Jan.	0	-	-	0	0	5	15+	1	0
115	23 Jan.	0	-	-	0	0	10	5	0	10+
116	24 Jan.	0	-	-	0	0	5	5	0	10+
117	24 Jan.	+	+	-	1	0	5	5	2	10+
118	24 Jan.	+	+	-	1	0	5	5	1	10+
119	24 Jan.	0	-	-	1	1	5	5	2	10+
120	24 Jan.	+	+	-	0	0	10	5	1	5
121	24 Jan.	+	+	-	1	0	20+	5	0	2
122	25 Jan.	-	-	-						
123	25 Jan.	+	-	-						
124	25 Jan.	+	-	-	W A T E R S T A N D I N G					
125	25 Jan.	+	-	-						
126	26 Jan.	+	-	-	0	0	2	10	3	1

Fauna (continued)												
Mites (continued)						Collembola						
Nanorchestes		Tydeus		Protereunetes		A		B		C		
Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot
-	0	-	50+	-	0	-	2-	-	-	-	100+
-	1	-	50+	-	0	-	10+	-	-	-	50+
-	0	-	20+	-	0	-	25+	-	-	-	10+
-	1	-	20+	-	0	-	10+	-	-	-	10+
-	0	-	20+	-	1	-	25+	-	-	-	10+
-	1	-	20+	-	0	-	50+	-	-	-	100+
-	0	-	20+	-	0	-	25+	-	-	-	100+
-	0	0	20+	-	0	-	10+	-	0	-	100+
-	0	0	50+	-	0	-	20+	-	0	-	100+
-	0	0	50+	-	0	-	10+	-	0	-	100+
-	0	0	100+	-	0	-	10+	-	0	-	50+
-	0	0	20+	-	0	-	10+	-	0	-	++
-	1	-	20+	-	0	-	10+	-	0	-	100+
-	0	0	10+	-	0	-	5+	-	0	-	20+
-	0	0	20+	-	0	-	5+	-	0	-	10+
-	0	0	20+	-	0	-	5+	-	0	-	10+
-	0	0	10+	-	0	-	25+	-	0	-	100+

Table 5. continued

Collection Number	Date	Flora			Fauna					
					Mites					
					Coccorhagidia		Stereotydeus		Eupodes	
		Algae	Moss	Lichen	Asp	Flot	Asp	Flot	Asp	Flot
127	26 Jan.	+	-	-	0	0	4	5	1	1
128	26 Jan.	+	-	-	0	0	2	3	0	0
129	26 Jan.	+	-	-	0	0	3	4	0	0
130	26 Jan.	+	-	-	0	0	1	6	0	1
131	26 Jan.	+	+	-	1	1	2	9	1	0
132	26 Jan.	+	+	-	0	0	3	10	1	0
133	26 Jan.	+	+	-	1	0	4	3	0	1
134	27 Jan.	+	+	-	0	1	10+	10+	0	0
135	27 Jan.	+	+	-	1	1	5	3	0	0

[a] A = *Isotoma* sp., B = *Cryptopygus* sp., C = *Friesia* sp.

[b] ++ = 500 upwards to an estimated 2,000.

Fauna (continued)												
Mites (continued)						Collembola						
Nanorchestes		Tydeus		Protereunetes		A		B		C		
Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot	Asp	Flot
-	1	0	5+	-	0	-	10+	-	0	-	100+
-	0	0	5+	-	0	-	10+	-	0	-	100+
-	0	0	5+	-	0	-	10+	-	0	-	100+
-	0	0	5+	-	0	-	100+	-	0	-	100+
-	1	0	5+	-	0	-	100+	-	0	-	100+
-	0	0	5+	-	0	-	50+	-	0	-	50+
-	0	0	5+	-	0	-	50+	-	0	-	50+
-	2	0	5+	-	0	-	100+	-	0	-	100+
-	1	0	5+	-	0	-	50+	-	0	-	100+